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GEOGRAPHICAL REVIEW

PUBLISHED BY

THE AMERICAN GEOGRAPHICAL SOCIETY
OF NEW YORK

JANUARY
1928

OUR CONTRIBUTORS

MR. PUTNAM is a member of the publishing house of G. P. Putnam's Sons. His avocation is exploration. In 1926 he organized and conducted the American Museum Expedition to Greenland, and he has been associated in an advisory capacity with many recent expeditions and explorations. He is the author of "The Southland of North America" (1913) and "In the Oregon Country" (1915).

PROFESSOR GOULD is a member of the Department of Geology of the University of Michigan, of which he is a graduate. In 1926 he was Assistant Director of the First Greenland Expedition of the University of Michigan led by Professor W. H. Hobbs.

MR. HANSON is an engineer. He has recently returned from Iceland, where he made a study of industrial possibilities. To the July, 1926, number of the *Geographical Review* he contributed the paper "Out-of-the-World Villages of Atacama."

MR. BENNETT is attached to the U. S. Bureau of Soils and Chemistry. The following works are indicative of the special sphere of his activities: "The Soils and Agriculture of the Southern States" (1921), dealing with the region south of a line drawn from Delaware to Kansas; "Some Geographic Aspects of Western Ecuador," "Agriculture in Central America" in *Annals Assn. of Amer. Geogrs.* September, 1925 and June, 1926, respectively; and, with others, "Possibilities for Para Rubber Production in Northern Tropical America," *U. S. Dept. of Commerce, Trade Promotion Ser. No. 40*, 1926, a report including some interesting soils maps. Mr. Bennett is now prosecuting studies in soil erosion in the United States.

MR. VON DER OSTEN prosecuted his Oriental studies at the University of Berlin, concentrating especially upon Hittitology. In 1925 he received a traveling Carnegie fellowship through New York University; and in 1926 Professor James H. Breasted, Director of the Oriental Institute at the University of Chicago, arranged for the additional support under which Mr. von der Osten in the summer of 1926 made his first exploratory trip to the ancient Hittite country of Asia Minor. Subsequently he was made a member of the Oriental Institute staff and Field Director of the Hittite Expedition whose second season of work has just been completed.

DR. AHLMANN is Docent in geography at the University of Upsala. During later years he has devoted himself both to physical and human geography. His work in physical geography includes special geomorphological and glaciological studies in Norway. He has, among other geographical journeys, made three in Italy; and during the winter of 1926–1927 he spent three months in Cyrenaica and Tripolitania. The results of his work have been published chiefly in English and French in the *Geografiska Annaler* and in Swedish in *Ymer*.

MR. MARMER has for many years been connected with the Division of Tides and Currents of the U. S. Coast and Geodetic Survey and is now serving as Assistant Chief of the Division. To the *Geographical Review* he has contributed several papers. He is the author of "The Tide" (1926), and of "Tides and Currents in New York Harbor," "Coastal Currents Along the Pacific Coast of the United States," and "Tidal Datum Planes," *U. S. Coast and Geodetic Survey Special Publs.*, No. 111, 1925; No. 121, 1926; No. 135, 1927, respectively.

JAN 22 1929

THE GEOGRAPHICAL REVIEW

VOLUME XVIII, 1928

PUBLISHED BY
THE AMERICAN GEOGRAPHICAL SOCIETY
BROADWAY AT 156TH STREET
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PUBLISHED QUARTERLY BY THE AMERICAN GEOGRAPHICAL SOCIETY
BROADWAY AT 156TH STREET, NEW YORK, N. Y.

Price, $1.25 a number Five dollars a year

Entered as second-class matter, January 22, 1916, at the Post Office at New York, N. Y., under the Act of August 24, 1912.

Acceptance for mailing at special rate of postage provided for in section 1103. Act of October 3, 1917, authorized on July 30, 1918.

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Index to the Bulletin of the American Geographical Society, 1852–1915. By ARTHUR A. BROOKS. With an historical and bibliographical note and a table showing the arrangement and composition of the series. xi and 242 pp. $2.00.

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Index to the Geographical Review, Vols. I–XV, 1916–1925. By ARTHUR A. BROOKS. iii and 432 pp. 1926. $4.50, unbound; $5.25, bound.

The Face of the Earth as Seen from the Air: A Study in the Application of Airplane Photography to Geography. By WILLIS T. LEE. With 67 oblique and vertical airplane photographs and 15 maps. xii and 110 pp. *Special Publication No. 4.* 1922. $4.00.

China: Land of Famine. By WALTER H. MALLORY. With a Foreword by DR. JOHN H. FINLEY, President of the American Geographical Society. With 91 photographs and 12 maps. xvi and 199 pp. *Special Publication No. 6.* 1926. $4.00.

Bering's Voyages: An Account of the Efforts of the Russians to Determine the Relation of Asia and America. By F. A. GOLDER. Vol. 1: **The Log Books and Official Reports of the First and Second Expeditions, 1725–1730 and 1733–1742.** With a chart of the second voyage, by Captain E. P. BERTHOLF. Vol. 2: **G. W. Steller's Journal of His Sea Voyage from Kamchatka to America on the Second Expedition.** Translated and edited by F. A. GOLDER and LEONHARD STEJNEGER. *Research Series Nos. 1 (1922) and 2 (1925).* The volumes will not be sold separately. $8.00.

Battlefields of the World War. A Study in Military Geography. By DOUGLAS WILSON JOHNSON. With sixty maps and block diagrams and over one hundred photographs; and separate case of plates comprising five detailed maps of the battlefields of the western front (1:300,000), three block diagrams, and six panoramas. xxvi and 648 pp. *Research Series No. 3*, 1921. $7.00.

Legendary Islands of the Atlantic: A Study in Medieval Geography. By WILLIAM H. BABCOCK. With 25 illustrations, mainly facsimiles of medieval maps. 196 pp. *Research Series No. 8*, 1922. $3.50.

The Recession of the Last Ice Sheet in New England. By ERNST ANTEVS. With a preface and contributions by J. W. GOLDTHWAIT. With 9 maps, 8 diagrams, 2 photographs, and, on six separate plates, curves and a colored map illustrating the recession of the ice edge. xiii and 120 pp. *Research Series No. 11*, 1922. $3.00.

The Vegetation and Soils of Africa. By H. L. SHANTZ and C. F. MARBUT. With a section on land classification by the joint authors and a note on a rainfall map of Africa by J. B. KINCER. With 1 text map, 49 photographs, and a separate case of two maps (in color) 1:10,000,000, each with inset, 1:25,000,000, showing vegetation (on inset: soils) and land classification (on inset: annual rainfall). x and 263 pp. *Research Series No. 13*, 1923. $5.00.

The Geographical Lore of the Time of the Crusades: A Study in the History of Mediaeval Science and Tradition in Western Europe. By JOHN KIRTLAND WRIGHT. With 10 maps, mainly facsimiles of medieval maps, and 2 diagrams. xxi and 563 pp. *Research Series No. 15*, 1924. $5.00.

Peopling the Argentine Pampa. By MARK JEFFERSON. With 55 photographs, 9 maps, and 4 diagrams. viii and 211 pp. *Research Series No. 16*, 1926. $4.00.

The Northern Ḥeğâz: A Topographical Itinerary. By ALOIS MUSIL. With 66 photographs, 12 drawings, 4 plans, and 4 maps in the text; in pocket, map of the Northern Ḥeğâz, 1:500,000, in brown and black, and index map, 1:2,000,000. xii and 374 pp. *Oriental Explorations and Studies No. 1.* 1926. $7.00.

Arabia Deserta: A Topographical Itinerary. By ALOIS MUSIL. With 96 photographs, 15 drawings, 8 plans, and 1 map in text; in pocket, index map, 1:4,000,000; in map case, map of Northern Arabia, 1:1,000,000, in 4 sheets, each 52 x 49 cm.; xvii and 631 pp. *Oriental Explorations and Studies No. 2.* 1927. $8.00.

Geography of the Central Andes: A Handbook to Accompany the La Paz Sheet of the Map of South America on the Millionth Scale. By ALAN G. OGILVIE. With an introduction by ISAIAH BOWMAN. With 2 maps in color and 41 diagrams and photographs. 240 pp. *Map of Hispanic America, Publication No. 1*, 1922. $3.00 (if purchased with the La Paz map, $2.00).

Map of Hispanic America, 1:1,000,000 [15.78 miles to 1 inch], Provisional Edition, North H-11, **Baja California Norte**; North G-12, **Baja California Sur**; North F-16, **Yucatán**; North F-18, **Santiago de Cuba**; North E-18, **Kingston-Port-au-Prince**; North E-19, **Santo Domingo-San Juan**; North E-20, **Lesser Antilles North**; North D-20, **Lesser Antilles South**; North C-17, **Panamá**; North A-17, **Río Mira-Islas Galápagos**; South C-19, **Acre**; South D-19, **Puno-Río Beni**; South E-19, **La Paz**; South E-20, **Sucre**; South F-19, **Iquique**; South F-20, **Río Pilcomayo**; South G-19, **Atacama**; South I-18, **Canquenes y Islas Esporádicas**; South L-18, **Península de Tai-Tao**; South M-18, **Isla Wellington-Lago Argentino.** $2.00 each sheet.

Mapa de la Republica de Panama, 1:500,000 [7.89 miles to 1 inch] compiled from over 100 original surveys, many of them unpublished. Printed in five colors. Follows in general the scheme of the International Map of the World on the Millionth Scale, but hypsometric tints have been omitted and the provinces shown in color instead. Accepted as official map by the government of Panama. 33 x 63 inches. 1926. $3.00.

The Leardo Map of the World of 1452 or 1453. Colored reproduction (measuring 28⅝ x 23½ inches, printed on sheet 35 x 30 inches) of map in the collections of the American Geographical Society. Accompanied by volume containing text by JOHN KIRTLAND WRIGHT describing the original map and a note by A. B. HOEN on the method of reproduction, with 3 photographs and 7 maps, viii and 90 pp. *Library Series No. 4.* 1927. $15.00 ($2.00 for text alone).

Separate Maps published in the *Geographical Review* and the *Bulletin of the American Geographical Society*, the majority in color. 25 cents each. A list will be sent upon request.

THE GEOGRAPHICAL REVIEW

VOL. XVIII JANUARY, 1928 NO. 1

THE PUTNAM BAFFIN ISLAND EXPEDITION

George Palmer Putnam

[With separate map, Pl. I, facing p. 40]

FIG. 1—A great berg in Hudson Strait.

I present you heere neither with Jason's voyage to Colcos, nor the Golden Fleece as yet, but with the best of my endeavours to the North-West, which we poore Discoverers are so jeered about . . .

My pen and selfe now is growne weary; and, hoping some other brave Spirit will enter the Lists and attempt the Enterprize, I rest—*Luke Foxe in the narrative "North-West Fox" of his voyage of 1631.*

ALMOST three centuries have passed since Luke Foxe returning from his voyage in search of the Northwest Passage wrote the above adjuration, and many have been the brave spirits who entered the lists. The map of Arctic Canada is the witness of their heroic adventuring. Today, however, the "voyage to Colchis" has resolved itself into the routine annual patrol of the Canadian Department of the Interior, while Hudson's Bay Company steamers annually carry away the Golden Fleece!

But not quite all the romance of the unknown has departed. This past summer the Putnam Baffin Island Expedition enjoyed the unique experience of sailing for some 500 miles on a course the charts show fifty miles and more removed from salt water. In consequence an area larger than the State of Connecticut has, cartographically speaking, been sunk beneath the surface of Foxe Basin; and Baffin

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FIG. 2—A view of Kangardluarsuk Fiord, in the Torngats region of northern Labrador (see Fig. 26).

Island, the great island accredited by the Canadian government with some 211,000 square miles of area, has been reduced by something over 5000 square miles. While the other coasts of Baffin Island have been visited recently, our knowledge of this portion of the southwest coast has remained virtually as it was established by Foxe, and the charting of it has stood unchallenged as originally laid down a hundred years ago by Parry from the data of Foxe's voyage.

In itself the newly traced shore line is geographically interesting. From the Expedition's camp at longitude 75° 15′ W. one could look miles inland to a horizon almost as straight as that over the sea, its monotony broken only by erratic boulders deposited by the retreating ice of earlier ages. In the deceptive light of these high latitudes where mirages are forever playing visual pranks these dark rocks seen from afar loom up like veritable Gibraltars only to shrink on approach to insignificant fragments in a sea of mud.

A wilderness of more dead monotony, a landscape of more utter desolation it is difficult to picture. In all that part of Foxe Land visited there is only one distinctive landmark—the great limestone highland that rises from the soggy flats of Blue Goose Prairie at the southeastern extremity of Foxe Basin. The contrast is startling. In sharpness of profile and general character this mesa looks as if it might have been bodily transported from the Colorado Desert and dropped into its present alien environment. It is a strange country.

Objectives and Personnel of the Expedition

The main objective of the Expedition was geographical exploration of this virgin territory of Baffin Island—work in the charge of Professor Laurence M. Gould of the University of Michigan, assisted by George Weymouth of Philadelphia, Monroe G. Barnard of New York, and John A. Pope of Detroit. The other general personnel of the party included Robert E. Peary and Wallace R. Hawkins, engineer and assistant; Dr. Peter Heinbecker, surgeon; Edward Manley, radio director; Maurice Kellerman, motion picture photographer; Junius B. Bird, botanist; and two junior members, David Binney Putnam and Deric Nusbaum.

Collateral work, secondary to the main purpose, was undertaken for four scientific institutions: Donald A. Cadzow, anthropologist, representing the Museum of the American Indian, Heye Foundation, collected ethnological and archeological specimens and data; Dr. Peter Heinbecker, Fellow of the National Research Council in Medicine, conducted various medical investigations;[1] Fred Lime-

[1] Problems taken up by Dr. Heinbecker included a study of certain starvation symptoms among the Eskimo and the sensitivity of these isolated people to certain toxins. All the natives now resident on the west coast of Baffin Island and many of those along the north shore of Hudson Strait, totaling some hundred and fifty, were blood-grouped.

killer, taxidermist, did zoölogical collecting for the American Museum of Natural History; and plankton collections for the Buffalo Society of Natural Sciences were secured.

The author was director of the Expedition, and Captain Robert A. Bartlett was master of the Expedition's vessel, the schooner *Morrissey*. The *Morrissey* herself, a two-masted Newfoundland fishing schooner of the older type, engined and thoroughly equipped[2] for summer work in the Arctic, gave excellent service despite rough usage and sundry mishaps.

FIG. 3—Landing on Sculpin Island, Labrador.

We sailed from Rye, N. Y., on June 12, 1927. Brigus, Newfoundland, was reached on June 20, and departure made thence two days later. Unusually far south along the Labrador coast we encountered ice and evidences of a late season. Climatic conditions throughout the summer indeed were adverse to our plans and progress. From the information of natives and traders familiar with other years, we judged the weather unusually bad. Out of sixty days spent within the entrance of Hudson Strait, only eight were genuinely fair throughout. For thirty-two days fog was recorded as present all or most of the daylight hours, often with rain. On two occasions the sun was not visible

[2] Two members of the Council of the American Geographical Society contributed to the Expedition—James B. Ford and Frederic C. Walcott. Other contributors were W. F. Kenny of New York, Gustavus D. Pope of Detroit, and George Grey Barnard of New York; the Museum of the American Indian, Heye Foundation; and the Buffalo Society of Natural Sciences. The balance of the budget was underwritten by the Director. It was the generous gift from Harrison Williams to the preceding season's Greenland Expedition which made possible much of the equipment utilized on this undertaking.

Special appreciation is due the Canadian authorities, who supplied promptly the requisite permits, primarily through the office of O. S. Finnie, Director of the Northwest Territories; to the U. S. Coast and Geodetic Survey for loaning valuable scientific paraphernalia; to the Bureau of Fisheries for net equipment; and to the School of Surveying of the American Geographical Society for instruments.

for six days in succession; and fog, rain, and gales prevailed in about equal proportions. The annual patrol of the Canadian Arctic Archipelago confirms the exceptional weather.

> The unusual weather conditions referred to were continual fogs—there being only a few fine days in the fifty-one occupied by the voyage—and the prevalence of easterly winds and gales instead of northwest winds which are usual during the summer. The fogs made navigation very difficult, especially in that part of the cruise in which the ship was north of the magnetic pole.[3]

From Cape Harrison north the heavy pack for the most part hung close to the shore, in vast drifting fields. We made our way chiefly well in by the land, working along through loose pans and leads of open water, dodging behind islands, and "cross cutting" through "tickles." North bound we visited briefly the settlements of Mokkovik, Hopedale, and Nain; stopped at the island Turnavik; and spent a day on Sculpin Island some twenty miles from Nain.

Ruins Near Nain

On Sculpin and other islands in the vicinity of Nain exist stone house ruins reputed to be of Norse origin, to which fresh attention is periodically directed. Ours was but a cursory examination, made during one strenuous twenty-four hours of daylight. Sculpin Island is some two miles by one; just to the east and accessible from it at low tide is an islet possibly a quarter of the size. Both islands are bare and rocky, stunted bushes and coarse grass struggling for existence in sheltered depressions. The highest hills of glacier-polished rock rise perhaps 300 feet.

The ruins themselves are on a small, rocky peninsula of the smaller island, the group containing eleven major structures. Near by is a protected landing place for small craft, with some indication of a partially artificial breakwater. The maximum height of the house walls still standing is about three feet, and the dimensions of a typical larger structure, oblong in shape, are approximately 12 by 18 feet. The chief walls, apparently averaging about 18 inches in thickness, are constructed of flat, natural stones. In at least one building a clearly defined doorway remains, with a rectangular entrance passage beyond it. Several such outer-entrance approaches are evident. Except for their rectangular feature they resemble the entrance tunnels of modern Eskimo winter houses in Greenland.

Mr. Hettisch, the Moravian missionary at Nain, told us that the Eskimo name his parishioners use for these relics signifies "the houses built by strange people." Apparently they know nothing of their origin. Dr. Gould constructed a map of the group, with measure-

[3] 1927 Expedition Completes Season's Work in Eastern Arctic, *Nat. Resources Canada*, Vol. 6, 1927, No. 10, p. 1.

ments of individual structures. Careful excavation in one house brought to light nothing. Thorough-going archeological study alone can determine with any definitude the comparative antiquity of the ruins and their possible historical significance.

Unrecorded Lakes in Northern Labrador

Cape Mugford we passed during the afternoon of July 1, a region of gorgeous scenery comparable with Norway's best. Outside the

Fig. 4—Labrador coast near Cape Mugford.

Cape itself, with its culminating pinnacle of the "Bishop's Mitre" 3000 feet above the sea, stand the islands of Nanuktut and Ogualik, shaggy masses of sheer rock; and inland a deep-indented palisaded fiord pierces straight into the heart of the mountains. It was an alluring scene on that calm sunlit evening; but vastly different three months later when, homeward bound, we buffeted our way around the black crags in the teeth of a southeast gale that stood the little *Morrissey* on her beam ends.

From Saglek Bay the ice clung close to land. For three days we were in and out of the pack and by July 4, thanks to a northeast gale, were well beset. That night the pressure of exceptionally heavy pans put our propeller and shaft out of commission. From the 5th to the 9th a battle ensued between the crippled *Morrissey* and the ice. Continuing northeast gales cemented the pack together and shoved us slowly southward. Once we were almost off Cape Chidley at the mouth of the Strait. When we got out of the pack, off the

"Four Peaks" in latitude 59° 40′, we had drifted[4] perhaps fifty miles south, always with the mountainous shore line in sight. Our escape was largely due to the excellent assistance of the motor whaleboat and launch, lashed astern and shoving when there came any chance of progress.

On a beach in a bight of Kangardluarsuk Bay, Captain Bartlett beached the vessel, and our spare propeller and shaft were installed in a rather strenuous job, the engineering credit for which is largely due Robert Peary. While repairs were in progress the adjacent

FIG. 5—The *Morrissey* in the ice off the Four Peaks region, northern Labrador.

territory was reconnoitered. Our anchorage lay just at the base of the mountains called on the chart the "Four Peaks" supposed to be the culminating heights of the Torngats.[5] From the bay we penetrated inland to an unrecorded tidewater lake,[6] some fifteen miles long, averaging over two miles in width, and possessed of a rugged Alpine beauty truly spectacular. Connecting it with a second lake

[4] C. O. Iselin, in "A Study of the Northern Part of the Labrador Current," gives an average figure for the velocity of the Labrador Current along the whole length of the coast as from 10 to 14 miles a day (*Bull. Natl. Research Council No. 61*, Washington, 1927, pp. 217–222). It varies considerably in place and season. Our own experience when homeward bound in September in the face of persistent southerly winds substantiated the contention of men familiar with the northern Labrador coast that after a period of such wind the current becomes practically non-existent until a shift in wind direction occurs.

[5] See R. H. Woodworth: Notes on the Torngat Region of Northern Labrador, *Geogr. Rev.*, Vol. 17, 1927, pp. 632–642.

[6] To these lakes and a limited number of the other hitherto unnamed geographical features explored by the Expedition tentative names were bestowed, subject to acceptance by the Newfoundland and Canadian governments. The suggestions have been submitted to the appropriate authorities who will also, of course, receive such of the Expedition's data as may be serviceable to them.

FIG. 6

FIG. 7

FIG. 8

FIGS. 6, 7, 8—In the Four Peaks country of northern Labrador. Figure 6 is Kangardluarsuk Fiord, looking westerly. Figure 7 shows the tide-water lake opening into Kangardluarsuk Fiord. In Figure 8 Gould is standing on the miniature hillocks of a small glacier whose ice is well covered with mud.

farther westward, is a freakish gorge over a mile long, narrowing to fifty yards in width, with precipitous walls (see Figs. 9 and 26). Through the 120 foot drop at its westerly end the overflow of the upper lake plunges, in a series of falls, to the semi-salt waters of its neighbor.

THE SOUTHERN SHORE OF BAFFIN ISLAND

On July 17 we passed into Hudson Strait, close to Resolution Island on the north shore, and late on the 19th anchored in Ashe Inlet on Big Island, some 300 miles from the entrance, chiefly to obtain water. The "furious overfall" of Davis[7] near Resolution, where seven-knot tides create veritable rapids, fortunately was negotiated on a clear, calm afternoon, with no pack about. The dangers of encountering heavy ice while passing through that belt of amazing whirlpools were evident enough even as it was.[8]

[7] See "The Voyages and Works of John Davis, the Navigator," *Hakluyt Soc. Publs.*, Ser. 1, Vol. 59, London, 1880, p. xxxvi.

[8] An interesting description of the hazards attending entrance to Hudson Strait, more pronounced in the days before auxiliary power, is contained in "The Private Journal of Captain G. F. Lyon of H. M. S. Hecla During the Recent Voyage of Discovery Under Captain Parry" London, 1824. He states (p. 13): "It will, however, give some idea of the difficulties we had experienced,

On July 22 we reached Amadjuak, the Hudson's Bay Company trading post on the north shore of Hudson Strait. There we picked up the Eskimo Avalisha, who promptly accepted the suggestion that we arrange with the Post to ration his family while he accompanied us. Seemingly most Eskimos are bred-in-the-bone travelers, and possibly this characteristic is especially strong in these Foxe Land people, who are essentially nomads. In a matter of ten minutes Avalisha had bade his wife goodby, rolled his "blanket" of caribou hide, hung about his neck the little skin bag containing his telescope and minor treasures, and was ready.

FIG. 9—The connecting canyon between the two lakes draining into Kangardluarsuk Fiord (compare the map, Fig. 26).

On the 25th we were at Cape Dorset, at the southwestern tip of Baffin Island, cordially received by the Company's manager and his wife. The place is typical of the smaller Hudson's Bay Company posts—the store, in whose attic the skins are stored, a blubber house, a warehouse, the manager's residence, and the inevitable little powder house perched up on a ridge to the rear (Fig. 30). At Dorset we established three members of the party to pursue their special occupations and took on board the Eskimo Kavaoo.

MILL ISLAND CIRCUMNAVIGATED

Deflected by fog and ice in our effort to work north along the Foxe Land shore, we found anchorage from July 27 to August 1 at Mill Island, a desolate mass of rock perhaps twenty miles in its longest dimension, some twenty miles south of the mainland and apparently about bisected by the 64th parallel of latitude. The exact position of the island could not be determined, for during our five

when I observe that we were 19 days in passing Resolution Island, a distance of about 60 miles."

The Canadian Government now has an expedition in the field investigating the navigability of the Strait in connection with the construction of the Hudson Bay Railway.

days there the sun not once was visible for observations. Definite record of any previous visit by white men appears to be lacking.

On the northern shore of the island toward the westerly end, we found excellent anchorage in a sizeable harbor to which the name "Morrissey Harbor" was tentatively applied (Fig. 28). The chief entrance carries deep water, but with strong tidal currents and whirlpools just outside. Our anchorage was in seven fathoms, mud bottom. Near by was no bottom at thirty fathoms. A circumnavigation of Mill Island was accomplished in the whaleboat. Its southeastern portion is comparatively bold, but to the west and northwest appear many dangerous shoals. The main axis of the island lies northwest to southeast, similar to that of adjacent Salisbury and Nottingham islands, and not north and south as shown on the charts. Further, a strait extends across the southeasterly portion of the island, making a secondary island perhaps a third of the area of Mill Island proper. This passage, probably running about northeast and southwest, steep-walled and apparently averaging nearly a mile in width, is almost exactly straight for six miles or more.

No present-day charts indicate this passageway, though reference was made to it in 1631. In Luke Foxe's journal is the entry for September 16:

> This morning I plyde it up to the West end of the Island [Mill], and, when the Tyde was done, I put into a through-let I named *Hurin's Through-let*, for that hee, upon the foreyard, conducted in the Ship.[9]

In an editor's note anent this paragraph Mr. Miller Christy, sometime council member of the Hakluyt Society, comments: "No doubt the narrow passage between Mill Island and the small island lying close to its western side." We venture to believe "Hurin's Through-let," named for the mate of Foxe's ship the *Charles*, was not any passage between the islets to the west and the larger island but actually this intersecting waterway. It would be graceful to restore the name of Hurin, doughty British sailorman, to the charts of today and appropriate to bestow a name upon Mill Island's lesser half.

Foxe also records the fact that Bylot, in 1615, gave Mill Island its name "because of the ice grinding against him like the grinding of a mill." The fabulously swift tidal currents, with their propensity for grinding the ice and swirling it fearsomely hither and yon, are as startling today as then.

Near our anchorage ruins of ancient Eskimo winter residences were found. There were two stone houses in a fair state of preservation, the walls still standing to an average height of some two and a half feet. These were rectangular with curved corners and meas-

[9] The Voyages of Captain Luke Foxe, of Hull, and Captain Thomas James, of Bristol, in search of a North-West Passage, in 1631–32, 2 Vols., *Hakluyt Soc. Publs.*, Ser. 1, Vols. 88–89, London, 1894, p. 381 (in Vol. 2).

FIG. 10

FIG. 11

FIG. 12

FIG. 10—When the storm-driven ice attacked the beached whaleboat at Cape Dorchester.

FIG. 11—As the tide receded the whaleboat was left stranded on the mud flats, with great piles of grounded bergs about. On the eastern shores of Foxe Basin.

FIG. 12—Beaching the whaleboat in a "blow of wind" at Cape Dorchester.

ured about sixteen feet by eighteen. Junius Bird excavated the ruins, gathering an interesting collection[10] of ancient artifacts of stone, bone, and ivory, including amulets, among which were a miniature polar bear cleverly carved in ivory and a diminutive conventionalized bird, with characteristic etched decorations.[11]

The West and North Coasts of Foxe Land

After six days of continuous bad weather at Mill Island the heavy ice visible to the north appeared to move apart somewhat, and we started up the west coast of Foxe Land. That was noon, August 1. On the afternoon of the 4th we reached Cape Dorchester. The actual straightaway distance traversed is not over one hundred miles, as we later determined. Much of the run was made in fog, some of it in and around ice, and all of it without an adequate sight of the sun. So, again, observations for position were impossible. Tides and currents were strong, and beyond the Trinity Islands the occasional glimpses of the mainland, through fog or over ice, gave no clue of exact locality. Obviously such navigation along an unknown coast has its difficulties.

The word "unknown" is applied to the western boundary of Foxe Land perhaps not with literal exactitude. However, in all the long list of explorations through and about Hudson Strait, commencing with Frobisher in 1576,[12] only three expeditions directly concerned western Foxe Land and the region of Foxe Basin proper.[13] On June 22, 1631, Luke Foxe entered the Strait, that September working north past Mill Island and along the west coast of Foxe Land, believing he reached a "farthest" in latitude 66° 47′.[14]

In the summer of 1821 Parry's vessels, the *Fury* and *Hecla*, sighted the Trinity Islands off the southwestern extremity of Baffin Island on their way to the western shores of Foxe Channel and Basin. Parry also records from a position a little northeast of latitude 65° and longitude 80°, "an appearance of land . . . from N. 82° E. to S. 53° E., being part of the coast discovered by Baffin, in the year 1615, and more minutely traced by Fox, in 1631."[15]

The record of other visitations is short. Probably whalers have

[10] Presented to the Museum of the American Indian, Heye Foundation.

[11] These specimens are now being studied: it is hoped later to publish an account of the findings in the *Geographical Review*.

[12] A good summary account of some of the earlier voyages through Hudson Strait is given in "Report of the Expedition to Hudson Bay and Cumberland Gulf in the Steamship 'Diana' Under the Command of William Wakeham, Marine and Fisheries, Canada, in the Year 1897," Ottawa, 1898.

[13] It was Parry who named "the great opening leading to Fox's Farthest . . . Fox's Channel." Boas makes the distinction between Foxe Basin proper (pointing out its essentially basin-like character) and Foxe Channel (Franz Boas: Baffin-Land: Geographische Ergebnisse einer in den Jahren 1883 und 1884 ausgeführten Forschungsreise. *Petermanns Mitt. Ergänzungsheft No. 80*, 1885).

[14] The Voyages of Captain Luke Foxe, p. 394.

[15] W. E. Parry: Journal of a Second Voyage for the Discovery of a North-west Passage . . . London, 1824, p. 30.

periodically sailed along the coast and occasionally penetrated more or less into Foxe Basin. Regarding one of these, Captain John Spicer, more will be said later. The only other vessel recorded as having sailed along the west Foxe Land coast is the *Bowdoin*, commanded by Donald B. MacMillan, which wintered at Bowdoin Harbor, near the Trinity Islands, in 1921–1922.

As to the western part of Baffin Island between roughly the latitudes of 65° and 70°, only two penetrations by white men are recorded. Bernhard Hantzsch in 1910–1911 made the east-to-west traverse from Cumberland Sound through Nettilling Lake, along the Koukjuak River to Foxe Basin, and thence north along the shore apparently nearly to latitude 69°. He died in June, 1911, on the coast in about latitude 67° 30′.[16] J. Dewey Soper, of the National Museum, Ottawa, made a traverse from Cumberland Sound to the Koukjuak via Lake Nettilling in 1925, and again in 1926 to the shores of Foxe Basin.[17]

On August 5 a party set out from Cape Dorchester in our motor whaleboat, to proceed northerly along the western coast of Baffin Island, so far as circumstances permitted, and to execute a route survey. The boat carried sufficient gasoline to fuel the Palmer engine for about six hundred miles together with rations for the party of seven for thirty days. A cache of food, with seventy gallons of gasoline, kerosene, and a supply of pemmican for possible emergency, was left at Cape Dorchester. This was more than sufficient to effect a return to Cape Dorset, if need be. The whaleboat's personnel comprised the Director, Gould, Weymouth, Barnard, Pope, David Putnam, and the Eskimo, Avalisha of Amadjuak. The craft itself is twenty-four feet long, entirely open, so that the conditions were not notably luxurious, especially in bad weather—and the weather was almost continuously bad.

As already stated, the weather had permitted no observation before our arrival at Cape Dorchester, the northwestern extremity of Foxe Land. We accepted its position as shown on the chart on faith because just then there was no chance for verification. Our course, after rounding the long finger of rocks and shoals which Dorchester thrusts out into Foxe Channel, lay true east and often slightly south of east. By the chart that was altogether wrong. We thought our compass probably eccentric—the performance of the needle in this region so near the magnetic pole is anything but trustworthy. And with the continued clouds it was impossible to check up thoroughly with our Bumstead sun compass, an instrument unaffected by magnetic whims and particularly useful to us.

[16] M. Rosenmüller: Bernhard Hantzsch und seine letzte Forschungsreise in Baffinland, *Mitt. Vereins für Erdkunde zu Dresden*, Vol. 2, 1913, pp. 669–716.

[17] See the note "Recent Canadian Exploratory Work in Baffin Island" in this number of the *Geographical Review*.

FIG. 13

FIG. 14

FIG. 13—A typical example of the heavy, dirty, old ice of Foxe Basin, stranded at ebb tide along the shore. In distance note the clusters of stranded bergs left by the receding water.

FIG. 14—A stranded "growler," or small berg, at low tide along the Foxe Land coast. "The mushroom motif predominated." Whaleboat anchored in distance.

FIG. 15

FIG. 16

FIG. 15—Countless times the whaleboat was left high and dry by quickly receding tides.
FIG. 16—"A rocky country studded with lakes and ponds"—approaching Blue Goose Prairie, northern Foxe Land.

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On the second and third days Gould was able to make some observations, not overly satisfactory. These showed us even more out of harmony with the map than the compasses hinted. Finally a thorough-going observation was obtained (see the map, Pl. I). Its results were fortified by a check-up of our chronometer; Monroe Barnard, using the portable radio receiving set provided by the Society, caught the noon time signals from Washington, removing chance of error in that regard. And subsequently these first findings were corroborated with astral as well as further solar observations by Gould, to whom credit for the technical work is entirely due.

Dorchester is a cape of granite and gneiss, with rocky hills fifty feet high. At its southern side the bay reaches inland some seven miles, that estimate including the tidal flats at its extremity. Countless fresh-water ponds and pools are scattered throughout the rocky promontory. Patches of grass are few and far between, and vegetation is almost totally lacking, even moss and the customary heather-like dwarfed shrubs being rare.

Eastward the coast is universally lower. It is, indeed, simply a ribbon of granite rising just above the high-tide contour, at low water hemmed by from a half mile to a mile of rocky tidal flat, and with a sprinkling of granite islets and reefs outside. There are no hills. On a coast perhaps seventy-five miles in length there seemed to be no elevations of even fifty feet within a dozen miles of the coast. It was a desolate shore. In twenty days we saw less than that number of seal and no bear. Ducks were infrequent. Signs of fox, hare, or caribou were lacking on the coastal strip, though doubtless there were many of the latter inland. We encountered a few ptarmigan and numerous snipe.

Ice lay thick along this coast on our outward journey. The pack, of old and dirty ice characteristic of Foxe Basin, jammed in against the points and shoals at flood tide, receding and changing position laterally on the ebb and at the whim of prevailing winds. The shore itself was festooned with an endless parade of grounded "growlers" and sizable pans, the bergs, high and dry on shelves of glacier-polished rocks, rearing aloft thirty feet and more at low water or again at flood tide showing but a fraction of their upper bulk. Every point was lined with them, as was also each protruding reef beyond the points. Picturesque they were, some of them huge, many of them fashioned by the tide-driven waters into grotesque shapes, a sort of gigantic mushroom *motif* predominating.

From what we saw of the movements of the great ice fields outside and could judge of the prevalence of shoals, it seemed it would be practically impossible for a vessel of any draft to navigate along these shores. Even for our whaleboat it was difficult and dangerous enough. Where the old pack ice came in close our only chance of

progress lay in "cutting corners"—that is dodging along close inshore as tide and ice movement permitted, often in less than a fathom of water and pretty much at the mercy of six-knot currents. Where a shoal was studded with grounded bergs and the pack prevented passage around it, we perforce cut through, sometimes in veritable

FIG. 17

FIG. 18

FIGS. 17 and 18—Photographs taken from the same spot near Camp Walcott on the northern coast of Foxe Land. Figure 17 shows high tide; Figure 18, low tide. The range of the tide is about 28 feet.

rapids where the tide raced madly over the shoals, often with only a few inches of water between us and bottom.

A large and deeply indented bay constituting the southeastern extremity of Foxe Basin marked the termination of our run easterly from Dorchester. West of its head in latitude 65° 32′ N., longitude 74° 30′ W., lay our base of operations which we named Camp Walcott. The land adjacent to the westerly portion of this bay and south from its head held a far larger measure of interest than the previously encountered territory. The shore itself, still granite and gneiss, is generally considerably higher, some of the headlands being distinctly

abrupt. There are numerous ledges, and the upper reaches of the bay are extremely shallow, low water exposing mud-and-rock tide flats probably five miles in width.

The small hills near the shore had maximum heights of perhaps one hundred feet. Farther inland to the south and west, the country opened up into marshy plains interspersed with "islands" of rock, both the meadowlands and rocky surfaces cut up with innumerable small lakes. Grass and moss abounded, and there were evidences of great numbers of caribou. The prevailing bad weather, it is believed, had driven the herds to better protection in a more hilly region visible farther inland. Two days of hunting bagged six caribou for our larder, periodically supplemented with duck, snipe, and ptarmigan. The latter and eider ducks were fairly numerous; a number of Arctic white owls were seen, some hare and weasels, and ample evidence of lemmings, but signs of fox were rare. The shallow ponds and prairies of the hinterland swarmed with geese. In the bay itself a single bearded seal and a white whale alone were observed.

To the southeast of our camp on the bay, about fifty miles distant, lay the one distinct landmark of the region. To this highland we back-packed, finding it a group of veritable mesas of limestone, with an average altitude of some seven hundred feet, rising from a flat, semi-inundated prairie but slightly above high-tide level. The strata proved highly fossiliferous. Even in our brief examination hundreds of fine specimens were seen.

For the vast marsh at the base of the Highlands, extending perhaps over an area twenty miles square, we are suggesting the name "Blue Goose Prairie." There the junior member of the party, David Binney Putnam, contrived to kill four of these extraordinarily shy geese. Through the subsequent identification[18] of one of the bird skins it developed that we had stumbled upon a populous summering place of the much-sought blue goose, whose nesting *locale* hitherto has remained an unsolved ornithological mystery. We saw no nesting places and no eggs, the season evidently being far too advanced. Most of the young seen were matured enough to fly. Presumably the migration southward this year commenced September 10. On that date we were in Chorkbak Inlet, about seventy-five miles almost directly south of this particular region; for two days and nights, quite continuously, magnificent "V's" of geese honked southward within our field of sight or hearing. None before that date had been observed.

The head of this great bay marks the end of the eastern sweep of the shore line; there it turns and extends west of north. And

[18] Examining this in New York, Dr. Frank N. Chapman of the American Museum of Natural History says: "Your bird is a blue goose (*Chen caerulescens*) passing from the downy plumage in which it was born to the juvenal or first flight plumage. It was obviously, therefore, taken on or in the vicinity of its nesting place and consequently marks the discovery of a spot in which this species breeds."

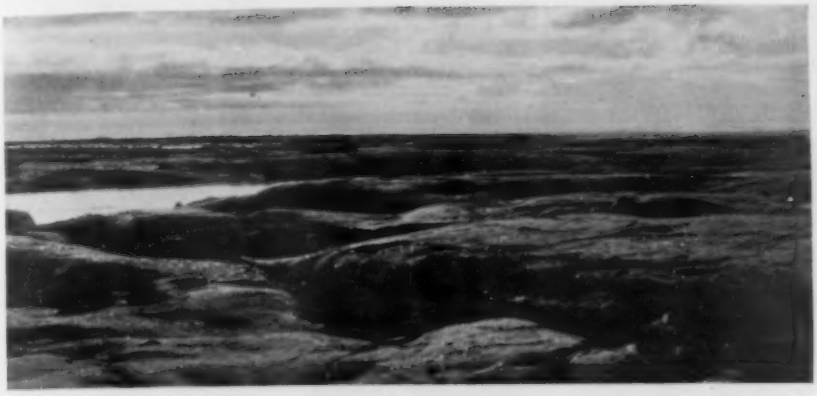

FIG. 19

FIG. 20

FIG. 21

FIG. 19—Typical terrain of the northern Foxe Land coast explored by the whaleboat party.
FIG. 20—Camp on the glacial polished granite of the Foxe Land shore line.
FIG. 21—Resting on the great prairie where the rare blue geese were shot, across which the party back-packed inland.

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beyond it the coast and visible hinterland assume a different character; the granite foreshore, with its rock-bound tidal flats, is succeeded by a terrain of mud, gravel, and swampy plain of limestone base, with mud tidal flats, amazingly level, reaching out to sea for miles.

From the bay we followed up that peculiarly horizontal coast zone for some hundred miles seeing no variety whatever. For prob-

FIG. 22—Along the base of the highland inland from the southeastern corner of Foxe Basin, Blue Goose Prairie at the left (see Fig. 33).

ably twenty miles inland there appear to be no altitudes of more than a dozen feet above high-tide contour. The mud flats reach out from the ribbon shore line often at least five miles, probably ten or more. The tides range from twenty to thirty feet with terrific currents. Fields of heavy ice and acres of "growlers" and loose pack seem forever plowing along the coast. Three miles off, the lead might show a fathom and a half of water. The technique of making a landing is to let the tide leave you dry on the mud, say half a mile out. Thence you sludge in to the semblance of beach, taking care not to be caught by the swift rising water of the next tide.

Altogether, it is a place of manifold navigation hazards and peculiar problems. One becomes increasingly convinced that a small power boat is the only possible craft with which to negotiate it. Light draft is essential, and a boat sufficiently handy to be beached and even hauled up, if need be, is advantageous. That point especially was brought home to us when we returned to Cape Dorchester. A gale of wind, driving full into the harbor and upon our beach, first brought a rough sea and breakers and then heavy ice. The whaleboat, anchored, would scarcely have survived the first, while the pack

would have made kindling wood of it in ten minutes. So we got her well up on the beach, in very satisfying safety. For such occasions, in amphibian navigation such as this, blocks and tackles make an admirable item of equipment, plus a boat of maximum sturdiness and minimum bulk.

In his "Journal of a Second Voyage," Parry says of the ice at the entrance to Foxe Channel: "We saw no more on our return to

FIG. 23—A nearer view of the scarp of the highland rising from Blue Goose Prairie.

the eastward, which circumstance agrees with the accounts of Baffin in 1615, and of Fox in 1631 . . . I have no doubt that the same clear sea would be found to extend some distance to the northward of where Fox turned back" (pp. 482–483). The whaling captain, Thomas McKenzie, has expressed the opinion that "on the east shore of Fox Channel there is generally open water in summer."[19] This season we encountered much ice in the eastern part of Foxe Basin in early August and at the northern end of Foxe Channel at the close of the month; and in eastern portions of the Basin heavy pack ice was found in great quantities by both the whaleboat party in the southeast and by the *Morrissey* farther north. From which it would appear that any freedom from ice in either Channel or Basin cannot be counted upon.

We returned to Cape Dorchester on August 25, having covered in the whaleboat approximately five hundred miles. And there Gould's further observations, both solar and stellar, removed any vestige of doubt as to the Cape's true position. Also there magnetic observations were made for the Carnegie Institution by George Weymouth, under Gould's direction, completing a series of three.

[19] Report of the Expedition to Hudson Bay . . . in the Steamship "Diana," p. 54.

Oceanographical Observations by Captain Bartlett

Throughout the greater part of the month of our absence in the whaleboat Captain Bartlett had the *Morrissey* in Foxe Basin (see Fig. 25). He prosecuted the first oceanographical work undertaken in the Basin. An extensive collection of plankton, gathered with surface nets at points representative of the area, was made for the Buffalo Society of Natural Sciences. In addition he dredged many specimens from the bottom, to be submitted to the Smithsonian Institution; took soundings and water temperatures; observed tides and currents; and released drift bottles for the U. S. Bureau of Fisheries. Captain Bartlett's summarization follows:

"In Foxe Basin our 'farthest' was off the entrance to Fury and Hecla Strait. Weather and ice conditions were about as unfavorable as could be, throughout. Constant fogs hindered nagivation, and near the Strait we were checked by heavy northwest gales. The Strait appeared quite free of ice and with favorable weather, and a little more time, I believe we could have gotten through comfortably although progress to the north would be problematical. Contrary to a commonly expressed opinion I believe in many seasons a small power vessel could negotiate the Strait comparatively easily.

"Near Cape Dorchester we saw some sizeable bergs, measuring perhaps 70 feet in height. Could they have come all the way from the mouth of Hudson Strait, an inland drift, up around Cape Dorset, of about five hundred miles? While there certainly is a prevailing westerly current along the north shore of Hudson Strait, I believe the prevailing current in Foxe Channel moves south. Could they have come from the north, by way of Fury and Hecla Strait? That is an even longer drift, in through Lancaster Sound and the Bay of Boothia. Is there possibly a glacier, comparatively near, bordering the waters north of Fury and Hecla?[20]

"We reached within about two miles of the village of Igloolik before we had to give up because of the northwester. However, from a neighboring shore we picked up two Eskimos who said the village was deserted just then, every one, as we understood it, being away hunting caribou.

"The ice of Foxe Basin is heavy and generally much like that found in Kane Basin. But it seems older and is amazingly dirty, covered with mud, pebbles, and kelp. Evidently what we saw was not made last winter—there was plenty of clean newer ice. I believe much ice must remain in the Basin from one year to another, and not move out seasonally as from Kane Basin and Smith Sound. There

[20] Robert Bell in "Report of an Exploration on the Northern Side of Hudson Strait" (*Canada Geol. Survey Ann. Rept.*, Vol. 11 (N. S.), 1898, Ottawa, 1901, p. 13M.) says: "During my visit to these regions in 1884 and 1885 vague reports reached me of the existence of glaciers on some parts of the shores of Fox Basin, but as no icebergs have been seen in the basin nor any known to come out of it, should there be any land ice in that direction it does not appear to reach the sea."

FIG. 24—Map of Foxe Channel and Foxe Basin showing depths determined by Captain Bartlett in two cruises, August-September, 1927. Many more soundings and other oceanographical data were obtained. The Spicer Islands were not sighted: presumably they are not in their charted position. Scale of map 1:3,250,000.

were enormous packs milling around the Basin apparently most extensive to the northeast. We were in them a good deal, and there and fog-bound along the west coast by Melville Peninsula, I had opportunity to observe somewhat how the currents churned around. There were no definite sustained directions of progress. The movement seemed pretty much circular. This substantiates my theory that much ice rotates around in the Basin, probably actually being cleared out only in summers of strong and protracted northerly winds.

"Twice we were within a few miles of the charted position of the Spicer Islands, blocked by ice from getting closer. I could see no land. Possibly their position is incorrectly set down. At all events, at about their given locality I found thirty-eight fathoms of water.[21]

"There was a surprising lack of animal life. We saw no bear, very few birds and waterfowl, and few seal. Walrus were encountered only near Cape Dorchester and near Fury and Hecla Strait. On the other hand the bottom flora and fauna appeared unusually rich."

Chorkbak Inlet

The *Morrissey* joined the whaleboat party at Cape Dorchester on September 4. Thence the vessel proceeded via Cape Dorset to Chorkbak Inlet, where five days were spent. Thus is Chorkbak laconically described by the "Arctic Pilot": "said to be the longest inlet on the north side of Hudson Strait, but it has not been examined." The map of the Northwest Territories for 1926 gives no indication of the inlet, but Boas on the basis of Eskimo accounts shows the fiord and its two arms, Sarbak and Sarbausirn, in dotted lines on his map of Baffin Land, and it appears similarly on the Admiralty Chart 2177.

R. J. Flaherty,[22] who wintered in southern Foxe Land 1913–1914, had reported Eskimo accounts of this little-known fiord. He was told that its tides, ice, and "maelstroms" were exceedingly dangerous and understood that in the past the inlet was used as part of a regular cross-country route from Hudson Strait to Foxe Basin. This latter was to us especially interesting, as actually the head of Chorkbak is distant from the established southeastern extremity of the Basin probably not more than fifty miles in a direct line, a fact previously unsuspected.

Of ice in Chorkbak we found none (September 10). The tides were strong, with a rise of between twenty and twenty-five feet; but

[21] The Report of the Expedition to Hudson Bay . . . in the Steamship "Diana" (pp. 57–61) includes a statement of the American whaling captain, John Spicer of Groton, Conn. It sets forth that in 1879 his ship the *Era* penetrated Foxe Basin. "On the 7th of August was beset; what I took to be water ahead turned out to be reefs and lowland, now called Spicer's Island, hardly seen from decks at high water" (p. 59). There is no record of other sighting of the islands.

[22] R. J. Flaherty: The Belcher Islands of Hudson Bay: Their Discovery and Exploration, *Geogr. Rev.*, Vol. 5, 1918, pp. 433–458. See p. 443 and the map, Fig. 1, p. 434.

after those of the Foxe Basin shores, they did not appear particularly formidable to us. The *Morrissey* proceeded up the inlet perhaps twenty miles, and examination by whaleboat was continued to the head of both branches, thirty-five to forty miles from the mouth, which itself is screened by countless islands, all uncharted—a continuous screen along the coast westerly to Cape Dorset.

FIG. 25—The *Morrissey* anchored in a bight of Chorkbak Inlet.

Chorkbak we left on September 12 and on the 17th passed out of Hudson Strait and headed south, homeward bound. Sydney, N. S. was reached on October 1, after we had logged in all some 6000 miles.

NOTE ON THE MAP OF FOXE LAND

In the current charts the western and northern coasts of Foxe Land are primarily based upon the findings of Foxe in 1631, as later interpreted by Parry in 1824.[23] Parry placed Cape Dorchester at about latitude 66° 28′—its position actually being 65° 32′, assuming that the name "Dorchester" shall be applied to the cape that is literally the northwestern extremity of Foxe Land. To analyze the pertinent and often conflicting passages would require too much space here.[24] Suffice to say that Foxe seems to have hit upon the latitudes of Cape Queen and Cape Weston (as placed on the present

[23] Parry, *op. cit.* See the map (4th at the end of his volume) entitled "Chart of a part of the North Eastern Coast of America, and its adjacent Islands shewing the Track and Discoveries of His Majesty's Ships Fury and Hecla, in search of a North West Passage, under the Command of Capt[n]. W. E. Parry in the years 1821, 1822, 1823."

[24] See The Voyages of Captain Luke Foxe, pp. 384–394. See also the earlier account of Foxe's journey, "Voyage of Captain Luke Fox," forming Narrative No. 12, pp. 152–186, in: "Narratives of Voyages towards the North-West, in search of a Passage to Cathay and India, 1496 to 1631. With selections from the early records of the Honourable the East India Company and from Mss. in the British Museum," by Thomas Rundall, *Hakluyt Soc. Publs.*, Ser. 1, Vol. 5, London, 1849.

chart) pretty accurately. His placement of Dorchester and Willoughby and his estimate of his own "farthest" are more hazy and, as to the former, incorrect—an error which almost inevitably affects the latter. Curiously, he sets down that from Cape Weston "the land doth trent to the s—ward of E—" which is what the land actually does at Cape Dorchester.

September 20, 1631, he made his "farthest," as he computed, "some mi. within the *Artick Cirkle*"—that is 66° 30′. The weather for Foxe apparently was as difficult as we ourselves found it, with a possibility that actual observations, if any, were undependable. Possibly the positions were built up chiefly on estimates. At all events, Foxe's log showed snow on the 19th; the entry for the 20th records "cloase weather, some snowie," and on the 21st, "this day wee see the Sun, but to no use."

In the construction of the map of Foxe Land by the Putnam Baffin Island Expedition the following positions were astronomically determined. A portable radio receiving set supplied by the School of Surveying of the American Geographical Society made possible the frequent checking of the chronometer:

Latitude 65°	25.9′ North*	Latitude 65°	31.5′ North*
Longitude 77°	45.6′ West	Longitude 74°	30.3′ West
Latitude 65°	25.4′ North	Latitude 65°	46.7′ North*
Longitude 75°	18.6′ West	Longitude 73°	51.1′ West.

The above positions were determined by observations made with theodolite; and for those starred, time signals were obtained on the date of the collection of the data.

Meridian altitudes of the sun, measured with the sextant for latitude, and approximate longitude from these data characterize this farthest north position:

Latitude 66°	17′
Longitude 74°	40′.

For further construction of the map from these positions as pegs to hang the data on, as it were, the simplest reconnaissance methods were necessarily employed. Except for a limited area about Camp Walcott and the southeastern bay of Foxe Basin, mapping was done from the whaleboat. This twenty-four foot boat drew scarcely two feet of water so that it was possible to keep fairly close to the coast in most cases. Distances were determined by the use of a taffrail log or, in places where shoals were too numerous to use the log, by time allowance—the rate of the boat having been previously checked for various engine speeds. A pelorus was used for locating more prominent points and features. Directions were determined so far

as possible by the Bumstead sun compass. Periods of bright sun were so transient that it was rarely possible to use this compass for steering the boat, but it did make possible the frequent checking of the two magnetic compasses which were constantly used.

On account of the inland trek from Camp Walcott to the highland, it was possible to locate points hereabouts by rough triangulation, supplementing data gathered from the boat.

Observations for terrestrial magnetism were made by a representative of the Carnegie Institution in 1922 at a point on the west coast and at two places on the north coast of Foxe Land, the latter being:

Latitude 65° 24.4′ North
Longitude 76° 41′ West

Latitude 65° 19.9′ North
Longitude 75° 54′ West.

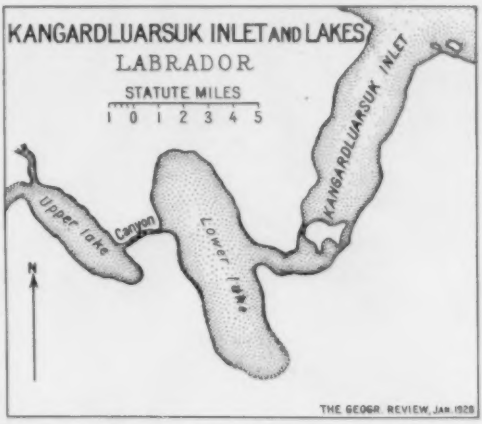

FIG. 26—Map of the lakes discovered draining into Kangardluarsuk Fiord on the Labrador Coast, 59° 36′ N. Lat. (see Figs. 2, 6, and 7).

These data furnished welcome reënforcement for positions estimated by us by dead reckoning on a part of the coast where weather prevented us from making satisfactory astronomical observations.

Report on the Physical Geography

BY LAURENCE M. GOULD

KANGARDLUARSUK INLET AND LAKES

Maps of the northern part of the Labrador coast are still very imperfect, and one cannot always be sure of his exact location. The inlet in which the *Morrissey* was beached and of which a reconnaissance survey was made appears to be Kangardluarsuk of the existing mariners' charts. A single solar observation for latitude indicated such a position (59° 36′ N.).

Proceeding inland from the head of Kangardluarsuk Inlet one first encounters a lake of salt water separated from the parent inlet only at low tide. Like the inlet itself it occupies a valley scoured out by one of the tongues of ice from the eastern side of the Torngats. Striations and other glacial markings are noticeably more evi-

dent here than in the rocks adjacent to the coast; their strike is parallel to the axis of the valley.

About a mile and a half beyond is another lake lying 160 feet higher. Unlike the lower lake it is not a typical rock-basin lake whose bed has been entirely scoured from the rocks by glacial ice, for its eastern shore consists in part of an imperfect moraine. It is comparatively shallow, especially along this shore where wave action has built a flat sandy plain of considerable extent. Winds have blown

FIG. 27—The *Morrissey* in the harbor discovered on Mill Island; looking approximately northeast.

the sand into small dunes, and a struggle is in progress between the encroaching sand and the dwarfed subarctic vegetation. Both the shapes of the dunes and the distribution of the vegetation indicate prevailing and persistent winds from the southwest. Beyond this sandy zone are numerous shallow ponds surrounded by muskeg.

On the lee side of the divide that separates the lakes are a number of small but permanent patches of ice which exhibit many of the characteristics of true glaciers. Outwash aprons are in process of active formation at their feet, and in some cases tiny lateral moraines have been developed. Their surfaces are covered with débris and exhibit on a small scale the same sort of cones, pyramids, and ridges that characterize some of the great mountain glaciers (Fig. 8). A few crevasses expose a blue-gray ice beneath the mantle of dirt.

MILL ISLAND

After the relatively low islands of Hudson Strait, Mill Island presents a fairly rugged appearance as approached from the north. It has been completely covered by a continental ice sheet, and its great convexly rounded surfaces of pre-Cambrian crystallines rise abruptly from the sea to heights of 200 to 300 feet. Farther inland these forms attain heights in excess of 500 feet. The symmetry and

perfection of these glorified *roches moutonnées* are modified by a rectangular fracture-fault system which is fairly spectacular in the perfection of its development and admirably exposed through the almost total absence of vegetation and of glacial drift except for that which has been reworked into beaches and associated forms. One set of fractures has a strike of N. 40 E., and at right angles to it is a second set equally prominent. Scarps of 50 feet are common along these lines, and there appears to have been some block faulting. One rectangular valley within the island has originated in this manner, and the large island lying to the southeast of Mill Island proper is separated from its parent mass by a graben.

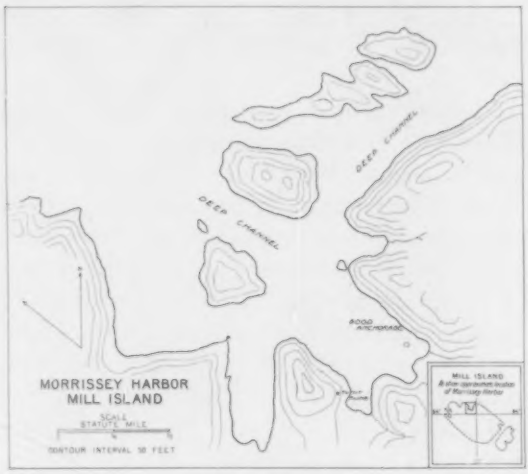

FIG. 28—Map of Morrissey Harbor, Mill Island.

The island is remarkable too for its series of terraces, far exceeding in their perfection any seen at other of the places visited on the Labrador coast and on Baffin Island. Proceeding inland from the head of Morrissey Harbor, one ascends the heights of the island by a great stairway of such terraces with treads spaced as follows: 40, 100, 170, 185, 225, 250, 280, 325, 350, and 500. These figures represent elevations above sea level measured in feet. At several other places on the island beaches were noted at an altitude of 500 feet. This figure does not, however, represent the total amount of postglacial emergence. At no place were the rocks covered by undisturbed drift, and erratics are by no means common on unprotected places; the whole island appears to have risen from a condition of almost, if not quite, complete submergence in postglacial time.

BAFFIN ISLAND

From Big Island to Cape Dorset the general character of the coastal region of Baffin Island is somewhat similar to that of southern Labrador. It is a ragged and forbidding coast with numerous inlets of varying size, fringed by barren rocky islands. Devoid of any notable landmarks, it is a bewildering place to navigate. The flattened convex profiles of the islands are duplicated in the hills and knobs on the mainland. So much alike are all these forms that an

elevation of the coast line would simply decrease the number of islands without sensibly affecting its present appearance, and conversely a submergence would but deepen the inlets and increase the number of islands.

It should be pointed out that there are three mountain ranges along the eastern side of Baffin Island with the highest nearest Greenland. It is the southern ends of these mountains that give character to the relief of the coast from Resolution Island to a point somewhere in the vicinity of Amadjuak. Mountains from 1000 to 2000 feet in height are common on the mainland, and the islands that border this part of the coast are likewise high and in many places rise sheer from the water to heights of several hundred feet. At Chorkbak Inlet the highest elevations would probably not exceed half of the smaller of the above figures, and from here westward to Cape Dorset the land does not appear to become more rugged. We penetrated inland to the head of Chorkbak Inlet and found that with northward progress the relief became considerably flatter.

Suggestions of a definite system of fractures and faults are found in the shapes of some of the coastal forms, particularly the inlets, and in the orientation of some of the islands; but it is behind this zone itself that their patterns are more distinct. An imperfect checkerboard design may be made out in some places but in no case on such a grand scale as that exhibited on Mill Island. Some of the side inlets from Chorkbak proper have rectangular outlines, and vertical scarps form parts of the walls of the inlet itself. It is apparent that faulting has played an important rôle in the development of this great fiord.

The rocks are pre-Cambrian crystallines, coarse biotite and hornblende gneisses and schists being the commonest types with a coarse-grained reddish granite present as intrusive masses and assuming considerable importance locally. Near Amadjuak there occurs a band of coarse crystalline limestone or marble.[25] Robert Bell, who charted the south coast of the island from Chorkbak to Big Island and who studied the geology of these shores, states that there are at least ten great bands of this limestone along this particular stretch of the coast. We positively located none beyond Amadjuak on the south coast and none along the whole stretch of the north coast. Nearing Cape Dorset a great band of whitish rocks several miles inland to the north was seen. This may be such limestone or marble.

From Cape Dorset to Cape Dorchester no stops were made, and the course of the *Morrissey* was too far from land for us to make any specific observations; but apparently with the northward trend the land forms along the coast become flattened. At Cape Dorchester a noticeably different character is evident in the topography. The

[25] Bell, *op. cit.*

general level of the land over the whole cape and apparently far inland is much lower. Most of the cape itself is less than 50 feet above high tide, and no elevations above 100 feet were found. The prevailingly rounded forms so characteristic of the south coast have been largely, and in some places completely, modified by the ribbed

FIG. 29—Reconnaissance geological map of Foxe Land with a diagrammatic section from north to south across the eastern border. (In the section Ordovician should be shown at B by horizontal ruling.) Scale of map 1:3,500,000.

structure of the rocks. Considerable amounts of reddish granite in conjunction with the structure give these rocks the appearance of sandstones, even from short distances. Any suggestion of the convex profile of glacial erosion is totally lacking in many places on the cape.

Eastward from Cape Dorchester the general level of the land becomes even lower, and for many miles beyond longitude 76° glacial

denudation has completely obliterated all evidence of structural control and has produced a surface almost completely in one plane. Low islands and shoals are particularly numerous along this part of the coast and project their elongate rounded forms above water like the backs of great whales. The effect produced is strikingly like that of the infinitude of islands along the northeastern shores of Georgian Bay in Canada.

Along the mid-sections of the north coast of Foxe Land garnet becomes such an abundant accessory mineral that the rocks can be properly referred to as garnetiferous gneisses and schists. Similar if not identical rocks were noted toward the head of Chorkbak Inlet.

In the vicinity of Camp Walcott and for perhaps twenty-five miles to the westward an intrusive porphyritic granite, with dikes and stringers of irregular shape cutting into the surrounding gneisses and schists, comprises a considerable part of the whole rock mass. The monotonous character of the landscape here is somewhat relieved by low knobs and flatly convex profiles of greater extent. But even here there are no real hills, and the general land surface does not exceed an altitude of 120 feet. About fifteen miles of the inland trek from Camp Walcott lay across this glacial plateau (Fig. 33). The greatest elevation noted was 160 feet. A much greater part of this surface is covered by shallow lakes and ponds than is indicated by the narrow strip on the map. These lakes are generally rock-bound, with basins quite free of débris except for small accumulations of organic matter. In some places drift comprises a portion of the shore line, replacing the rocky bank with soggy and slippery muskeg. In not a few places where the water level of these rock-bound lakes had fallen, a black strip between the two levels was conspicuous. This black stain proved to be a superficial crust quite like certain types of desert varnish in appearance. Mr. M. W. Senstius informs me that the phenomenon is common under similar conditions in Canada and that the black stain is manganese dioxide.

Blue Goose Prairie is part of a very recent coastal plain. It is really a great swamp of grassy bogs and shallow lakes. One sees patches a few yards or rods across that normally lie above water level whereon is exhibited in considerable perfection the results of the subarctic process of solifluction which produces hexagonal forms of bare soil, surrounded by grassy fringes. Few of these upheaved masses were more than three or four feet across.

Reference has already been made to the contrast in physiographic form presented by the great limestone mesas beyond Blue Goose Prairie. Polished and striated masses of pre-Cambrian crystalline rocks, exhibiting all the signs of intense denudation by a continental ice sheet, end abruptly against a high, flat, utterly barren mesa. So rapid has been the weathering of the limestone that the highland

FIG. 30

FIG. 31

FIG. 32

FIG. 30—Hudson's Bay Company post at Cape Dorset.
FIG. 31—Terrace at 60 feet across the bay from Cape Dorset.
FIG. 32—One of the countless raised beaches of northern Foxe Land, inland from Camp Walcott.

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exhibits no evidence of having ever been glaciated, yet there is no reason to suppose that it was not completely covered by the same ice sheet that so profoundly changed the adjacent terrain. The canyons that cut across it are steep-walled and generally have wide flat bottoms strewn with boulders. At the time of our visit these canyons were occupied only by small streams and ended at the edge of the mesa in alluvial fans across which the streams dwindle or are completely absorbed. The stream from the fifth canyon (see Fig.

Stream and lakes
Irregular glaciated terrain with countless shallow pools
Generally low with few elevations of rock
BLUE GOOSE PRAIRIE
N
BLUE GOOSE PRAIRIE
near-tide-level swamp with many lakes and ponds
INLAND TREK
CAMP WALCOTT TO THE HIGHLAND
STATUTE MILES
1 0 1 2 3 4 5
Beaches and terraces of reworked glacial materials
HIGHLAND
Limestone mesa elevation 650 to 700 feet
THE GEOGR. REVIEW, JAN. 1928

FIG. 33—Map showing the character of the terrain crossed in the trek from Camp Walcott to the highland.

33) is the largest and is the only one that reaches the prairie with any degree of the volume it possesses within its canyon.

The mesa profiles of the highland are due to the fact that the topmost 30 to 50 feet of the limestone composing them is considerably more resistant to weathering and erosion than the underlying strata. Not that the cap rock is notably resistant, for it is a very porous nodular limestone often conspicuously jointed, but the underlying beds are mainly a blue-gray, fissile calcareous shale which weathers with extreme rapidity. Where exposed without the more resistant cover rock the shale becomes gullied into a sort of miniature badland relief. Irregularly disposed through it are strata of limestone like the cap rock; and where the canyons cross are rapids or cascades. Here, then, in these highlands a landscape has developed, not under conditions of special aridity which one associates with its mesa form, but rather by intensive frost action under ideal conditions of no vegetation and advantageous rock structures. Furthermore, it is only recently that the foot of the north façade of the highland was washed by the waters of Foxe Basin. The rapid cutting by the waves in the weak shales below the harder cap rock has apparently been a

very important factor, for the sharp profiles of the mesas are restricted to this side of the highland.

Where the coast trends northward the topographic expression of this sedimentary formation is that of an extensive plain so utterly flat that its slope is imperceptible. Likewise with an equally flat gradient it passes beneath the waters of Foxe Basin where it is covered with soft calcareous mud. A vertical fluctuation in the tides,

FIG. 34

FIG. 35

FIG. 34—Descending into one of the canyons of the highland, 50 miles inland from the southeastern extremity of Foxe Basin.

FIG. 35—Bottom of one of the canyons of the highland where many fossils were found.

as great as thirty feet in places, exposes muddy tidal flats of extraordinary width, whereon ripple marks bear testimony to the strong currents developed by the changing tides.

The floor of the southeastern bay of Foxe Basin is composed of the old basement complex of pre-Cambrian rocks so that the limestones and shales exhibit practically their entire thickness in the mesas of the highland. This occurrence, further, probably represents a maximum thickness for this formation; for to the north it is represented by only a few feet of strata unless there is an abrupt and even precipitous change in the slope of the underlying pre-Cambrian rocks, and this seems entirely unlikely. The western limits of this formation are clear-cut, as indicated on the geological map. We did not penetrate far enough inland to reach its southern limits; but the contact with the older rocks below does not seem to be far north of the head of Chorkbak Inlet, for fragments of limestone apparently transported by water and but little worn and containing fossils like

those of the highland were found near the head of this great fiord. These sedimentaries are probably of Ordovician age.[26]

The nature of the eastern shore of Foxe Basin had already been deduced from Eskimo information and the presumed extension of the Lower Paleozoic limestones west of Lake Nettilling. Bell, writing in 1898, said:

> The scanty information we possess goes to show that Fox Basin is partly bordered on both sides by comparatively low land occupied by undisturbed fossiliferous Silurian limestone. Dr. Franz Boas ascertained the existence of these limestones on Lake Nettilling and he states that southward of the lake they rise into low hill-ranges. He also says: 'We will not be far astray if we connect this extensive Silurian district with the limestones which occur to the south of Igluling and which form the flat eastern half of Melville Peninsula. . . . It must be important for the problems of glaciation to survey the *inner* rim of the enormous basin formed by the chain of mountains of Davis Strait, the plateaus of Nugumit, Kingnait, Sikosuilat, Southampton Islands and Melville Peninsula.'[27]

Comparison may be made with the low limestone coast of the eastern side of Melville Peninsula explored by the Fifth Thule Expedition, in part "so low that one could hardly tell positively whether one was on the ocean ice or on land at a time when everything was covered with snow."[28]

Our first actual knowledge of the eastern coast of Foxe Basin is due to Bernhard Hantzsch. He explored northward from the mouth of the Koukjuak River for a distance of about 250 miles by sledge to a point in latitude 68° 45′. According to his account[29] the character of this stretch of coast is about as follows:

> Near the mouth of the Koukjuak the coast is entirely flat. A little beyond to the north boulder ramparts about 6 to 9 feet high parallel the coast and also occur farther inland. The shore line itself is in part exceedingly sinuous, in part smooth and without major indentations. Farther north the character of the coastal belt changes completely. Gneiss or granite hills interrupt the coastal plain more and more frequently. In places these hills abut almost directly on the shore, elsewhere they leave a foreshore over a mile wide. Their margins are often dissected by elongated lake-filled valleys. They are 30 to 50 feet high, increasing to 180–250 feet in the north.
>
> Offshore the coast is bordered in places by numerous rocky islets and reefs rarely exceeding 30 feet in height. North of about latitude 67½°, however, the offshore islands increase in size and height, a group of especially large islands lying abreast of the shore between 68° 20′ and 68° 45′. In general these islands are 120–250 feet high, although elevations of 300–350 feet and even of 450–600 feet occur.
>
> Inland the terrain increases in elevation as one goes northwards. Near the Koukjuak it is still low, although undulating. Limestone boulder ramparts 10–15

[26] The fossil collections are not yet in hand for study, but enough forms were recognizable in the field to indicate the probable age. More cephalopod genera were found than any other types, though the easily recognized gastropod Maclurea was the commonest single form. Bryozoa, brachiopods, corals, and a few trilobites were also collected.

[27] Bell, *op. cit.*, p. 17M.

[28] Knud Rasmussen and Associates: The Danish Ethnographic and Geographic Expedition to Arctic America, *Geogr. Rev.*, Vol. 15, 1925, pp. 521–562; reference on p. 556.

[29] Rosenmüller, *op. cit.*, especially pp. 705–715.

feet high, sometimes 30–35 feet high, and gneiss ridges 20–25 feet high here cover the ground. Gradually the land rises, but for a time the level character of the landscape is maintained inland as on the coast because of the predominance of plains both large and small. From latitude 67½° on, at which point a wide river debouches, high, long, steep-sided, and flat-topped ridges are visible inland on the horizon. At first they are 300–600 feet high, but farther north they seem to attain as much as 1500 feet. Deep valleys and gorges, often occupied by lakes, dissect them. In the last part of the journey, say north of 68°, the ridges decrease in height and their upland surfaces are more rounded; only their abrupt slope on the seaward side remains characteristic of this region. The rocks are predominantly crystalline, although some limestone occurs. Far to the north large areas are evidently covered by an ice cap.

Glaciation and Post-Glacial Emergence

To one who is familiar with the polished, striated, and grooved forms that abound in the glaciated areas of the Great Lakes and central Canada, the rocks of Baffin Island seem peculiarly devoid of such markings. One's first impression is that the glaciation must have been more ancient here than in the northeastern United States and Canada. There is still too little information available to demonstrate that such is not the case. The conspicuous paucity of fresh glacial markings is most notable along the coast, but even inland to such distances as the head of Chorkbak Inlet, evidences of glaciation are not prolific.[30] The cumulative effects of frost action on the totally unprotected rock surfaces have apparently been very great in postglacial time and have largely eliminated the shallower striations and grooves. On the greatly flattened surfaces along the north-central coast of Foxe Land, however, striations and chatter marks are more common. One must, however, be cautious in interpreting them. Great masses of débris-laden ice are pushed up onto the flat shores by rising tides and often shoved along on the rocks for considerable distances. Scratches identical in appearance with true glacial striations are thus produced, a process seen in actual operation. It does not seem probable that sufficiently large masses of ice could be moved in this fashion so as to form chatter marks, and it was these markings that were sought along this coast in attempts to decipher the directions of ice movement of glacial time. One gathers from a study of such directions that the ice which denuded Foxe Land came from a center to the north and east—some place perhaps north of Nettilling Lake, where according to Eskimo accounts there is still a large ice cap.

From Big Island to Cape Dorset, whenever the mainland was in view, there were few times when the horizon of monotonously rounded forms of glacial origin was not broken by the even profiles of old strand lines. So few stops were made that it was not possible to ascertain

[30] Bell, *op. cit.*, p. 29M.

the altitudes of most of these old beaches or terraces. None were noted at heights even approximating those of the highest hills. Bell determined the elevation of a number of the terraces along this stretch of coast. He found that altitudes as great as 400 feet were not uncommon and notes one terrace at 528 feet.[31] Amadjuak is built upon one of such a series of terraces. The Hudson's Bay Company post at Cape Dorset is likewise on a former beach scarcely 25 feet above present sea level, and directly across the bay from it is a pronounced terrace at 60 feet (Fig. 31). But it is along the more favorably located parts of the north coast of Foxe Land that these remnants of former shore lines are particularly numerous and surprisingly new.

It seemed that all over Cape Dorchester, wherever there had been a secluded zone, beaches had been developed at nearly all levels. The fresh unweathered character of the sub-angular pebbles that compose them is striking. Twenty feet above sea level on the south side of the Cape is a beach in which the pebbles are as loose and as unweathered in appearance as those of the beach in process of formation immediately below.

Along the central part of this coast of Foxe Land, where the land is so flat over great areas, there is an almost total absence of beach forms, either present or ancient, simply because there have been no places for them to establish themselves. But within the relatively more rugged region about Camp Walcott, beaches, bars, and spits of former levels are numerous. The camp itself was located on a beach but newly raised from the sea. The most extensive terraces noted are developed from reworked glacial clays and abut on the highland on the west. Below these terraces there are at least two distinct beach levels between the foot of the highland and Blue Goose Prairie. From the rim of the mesa one looks down to the north to see a double series of undistributed bars or barriers with hooked spits impounding elongate lagoon-like lakes. At no place along the coast does the period of uplift appear to have been more recent than here.

It is evident that the raised beaches and associated forms are neither persistent enough nor widely enough developed to give a definite measure as to the maximum amount of uplift. Daly[32] and others who have made extensive physiographic studies in arctic or subarctic lands have worked on the principle that on propitiously situated hills or forelands on a glaciated shore where the surf from the open ocean could be felt, the existing lower limit of undisturbed glacial erratics marks the highest limit at which the sea has existed since glacial time. Our progress along the south coast was too fast to make out any definite, continuous, boulderless zones or accordant,

[31] Bell, *op. cit.*, p. 30M.

[32] R. A. Daly: The Geology of the Northeast Coast of Labrador, *Bull. Museum of Comp. Zoöl. at Harvard College*, Vol. 38 (Geol. Ser., Vol. 5), 1902, pp. 203–270.

FIG. 36

FIG. 37

FIG. 36—West coast of central Baffin Island. The mud flats, at low tide, reach out five miles and more from the shore line.

FIG. 37—The desolate reaches of mud, gravel, and grass, utterly level, characteristic of the western Baffin Island coast south from the mouth of the Koukjuak River.

undisturbed, boulder-covered heights. But where we penetrated inland by way of Chorkbak Inlet the paucity or total absence of balancing rocks and erratics on the hills and even on gentler slopes was noteworthy.

In the whole reach of the coast from Cape Dorchester to the eastern limits of Foxe Basin no recognizable undisturbed glacial or fluvio-glacial deposits were found—no plaster of glacial clays even on the flattest rocks, such as one finds, for instance, in the Holstensborg hinterland of Greenland and such as one might expect to find in a region so recently glaciated as this one probably has been. In all of our inland treks along this coast no balancing rocks were observed, and erratics were conspicuously scarce on the few gentle hills and knobs that rise above the general level. It was our custom to build cairns for markers on the higher knobs as we journeyed inland, and we always found it necessary to carry up the rocks for this purpose from lower levels.

If we suppose a line drawn from the head of Chorkbak Inlet northward along the western side of the highland formation to be the eastern boundary of Foxe Land, then one's impression of this land as a whole is that the southern coastal zone is the highest part and that it gradually flattens toward the north to pass beneath the waters of Foxe Basin with the flat gradient already noted. A large part of Foxe Land is then structurally or physiographically a part of Foxe Basin and may have arisen from a condition of almost if not quite complete submergence in postglacial times. This conclusion is entirely legitimate if the amount of uplift here is at all of the order of that of Mill Island which lies but 25 miles to the south of the mainland and where well-defined beaches are found at elevations of 500 feet above sea level.

One has but to note the present appearance of the northern shores of Foxe Land and the coast trending northward from the great southeastern bay with its unbelievably wide tidal flats, to vizualize how great areas of Baffin Island have but recently been born and how the process is still in operation.

FOXE LAND
BAFFIN ISLAND

TO SHOW ROUTE SURVEYS
BY
PUTNAM BAFFIN ISLAND EXPEDITION
1927

Scale 1 : 1 700 000
STATUTE MILES
10 5 0 10 20 30 40

Surveys
Expedition's Obs. Stations
Carnegie Institution, 1922

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A. Hoen & Co., Baltimore

THE RENAISSANCE OF ICELAND

Earl Hanson

ON May Day last year (1927) I witnessed a labor demonstration in Reykjavík. Some three hundred men and women marched down the street carrying red flags and communistic banners, singing the International. It was the sign of a new Iceland. Even at the time of my first visit in 1920 the country had had no experience whatever with labor trouble.

Paradoxically enough, labor trouble in Iceland is a sign of progress, of reorganization and growth, economically, financially, politically. A profound change is coming over the life of the nation. For centuries Iceland has been effectually cut off from the rest of the world, "a backwater of civilization.[1]" They were bitter centuries, and their lesson has been well learned. Iceland today is finding its salvation by becoming a part of our world organization of interdependent units. Here is a group of people, about equal in point of numbers to the population of Knoxville, Tennessee, carrying out or about to carry out most of the functions of a modern nation in times of peace. Whether or not the nation will ever be a very important unit is immaterial. The importance to the Icelanders is enormous.

Iceland As a Testing Ground

Any change that takes place in Iceland is worth watching. Nowhere else in the white man's world do we find the same purity of conditions, the same opportunities for studying the life of modern man or for the testing of social theories, from the Malthusian to the Marxian. For here is a group small enough for convenient observation and yet large enough and diversified enough to be taken as a unit, demonstrating most of the processes and factors that enter into our complex life. One important item is lacking in the list—warfare and its attendant preparedness. Iceland gained its independence less than a decade ago without shedding one drop of blood: she has not a vestige of an army and has only three small fishing patrols for a navy. But this lack in itself opens a unique opportunity for study to the economist, not to mention the pacifist and the militarist. And we can observe the changes in the life of a people that come with the "modernization" of their country and a readjustment of economic

[1] In the *Geographical Journal* for July, 1927 (p. 49), Mr. J. H. Reynolds says: "It seems inevitable that Iceland must always remain a backwater of civilization"; but his paper comparing Iceland in 1872 and 1926 shows the remarkable progress made in the island.

UNIV. OF

FIG. 1—Map showing the distribution of the population of Iceland. Data from the census of 1920. In the placing of the dots use was made of Gunnlaugsson's map of 1844, scale 1:480,000, which shows towns, trading settlements, and farmhouses. There has been little change in the inhabited area since this date, though administrative divisions have been changed. Where available the excellent sheets of the Topographical Section of the Danish General Staff, scale 1:50,000, and new series, 1:100,000, have been consulted. The complicated nature of the seasonal shifting of the fishing population, affecting some 18,700 people, does not permit representation on this map (compare Söderlund's Population Map of Norway, 1922). Scale of map, 1:4,500,000.

conditions, hygienic changes, growth of population, shifts in population, and later undoubtedly the more subtle changes in racial characteristics, physical as well as psychological.

The Icelanders are a homogeneous people, speaking one language without dialects.[2] Population numbers have remained unaffected for a thousand years by immigration and, except for the last decades of the nineteenth century and the first few years of the twentieth, by emigration.[3] Racial characteristics have developed through a millennium of effective isolation, uninfluenced by "new" or "foreign" blood. And even the original stock of the population is open to study. The "Landnámabók," the Book of Settlements, lists many of the more important settlers who came to the island in the ninth and tenth centuries, giving names, places of settlement, locations of their old homes, and in many cases even genealogies. Most of these settlers were Norwegian or at least Scandinavian. Some question can be raised as to the number that came from Britain. Professor Hannesson estimates it at thirteen per cent, pointing out that of these too a certain number were undoubtedly Scandinavians.[4] Others estimate the Celtic percentage at about twenty-five. Jon Stefansson states that fully one half of the settlers came from the British Isles and goes so far as to call Iceland a British colony.[5]

The Historical Background[6] and the Population Curve

During the eighteenth century Iceland was stagnating, indeed at times was on the verge of extermination. The primary cause is simple—the trade monopoly of the Danish government. The island was Danish territory, with practically no voice whatever in the management of its own affairs. All trade in the country was either carried on by the state or leased to private individuals in Denmark, much as is the trade in Greenland today. Heavy punishments were inflicted on Icelanders who infringed the monopoly by occasional barter with "foreigners," Englishmen or Germans. The condition was not a healthy one. The Danish merchants did not make much money out of poverty-stricken Iceland. Imported articles, lacking the stimulus of competition, were often of inferior quality. Flour was wormy, timber rotten. The country could not thrive without trade. The land itself offered too few natural resources. Little was grown but

[2] Old Norse. "The Icelanders can read and understand their literature of the twelfth and thirteenth centuries much more easily than an Englishman can the works of Shakespeare." See "Iceland," published 1926 by the National Bank of Iceland and reviewed in this number of the *Geographical Review*.

[3] Icelanders and those of Icelandic descent in North America number some 25,000.

[4] Gundmundur Hannesson: Körpermasze und Körperproportionen der Isländer: Ein Beitrag zur Anthropologie Islands, Reykjavík, 1925, p. 6.

[5] Jon Stefansson: Iceland: Its History and Inhabitants. *Ann. Rept. Smithsonian Instn. for 1906*, pp. 275–294; reference on pp. 287–288.

[6] Knut Gjerset: History of Iceland, New York, 1924.

hay, which was turned into meat and wool and dairy products. There was no grain, no timber, no coal, no iron. All of these products, necessary to the life of civilized man, had to be imported in exchange for fish.

Under such circumstances any unfavorable event was a catastrophe, and catastrophes occurred in plenty. The Icelanders were decimated by earthquakes and volcanic eruptions, by famines, by epidemics. In three years (1782–1785) Iceland lost almost one-quarter of her population (Fig. 2). It was during this period of misery that the first steps were taken toward the emancipation of the country, political as well as economic. One after the other of the Danish merchants who held the Iceland concessions failed. An incessant lament and wail of protest went up from the Icelanders themselves. The monopoly was partially abolished by ordinances of 1786 and 1787, and trade in Iceland was thrown open to all Dano-Norwegian subjects.

The behavior at this time of the population curve is of extreme interest. No definite figures on population are available before the year 1670, although it has been calculated at over 70,000 in the early fifteenth century.[7] In 1670 it stood at 50,000, in 1703 at 50,444. The curve swings up and down with violent vibrations. Iceland was pointed out as proof of the theory that populations, when left to themselves, do not grow. In the country itself there was a superstition that 50,000 was an unlucky number—reaching it was a signal for another of God's many vengeances on a stricken people. But with the lifting of the trade monopoly the population curve takes on a smoother aspect, the downward swings are shallower and less abrupt, the curve staggers upward toward the 50,000 mark and passes it in 1832, probably never to return.

The partial lifting of the trade monopoly, however, was not entirely a success as far as either Iceland or the mother country was concerned. In the early part of the nineteenth century Denmark became actively involved in the general Napoleonic turmoil and could pay little attention to her isolated colony. British and even American traders gained some headway in Iceland, but the island still suffered from lack of competitive trade.

One important factor attended the improvement, slight as it was, in Iceland's national health. The spirit of nationalism, caught from that general zeal for liberty which spread over the whole western world, took a strong hold.

The nineteenth century was marked by a gradual political and economic emancipation. The Althing, the general assembly for the whole island, established in 930, was restored in Reykjavík in 1843. During the eighteenth century it had struggled on impotently at Thingvellir, until finally abolished in 1800. In 1848 the first weekly

[7] Hannesson, *op. cit.*, p. 30.

paper was issued. In 1854, as the result of a petition to the Danish government, the trade monopoly was entirely abolished, and Iceland was thrown open to all nationalities with immediate beneficial results.

In 1874 Iceland received its first constitution. In 1904 the country got home rule, in 1918 complete independence. Today Iceland is a free and sovereign kingdom united with Denmark by a common king.[8]

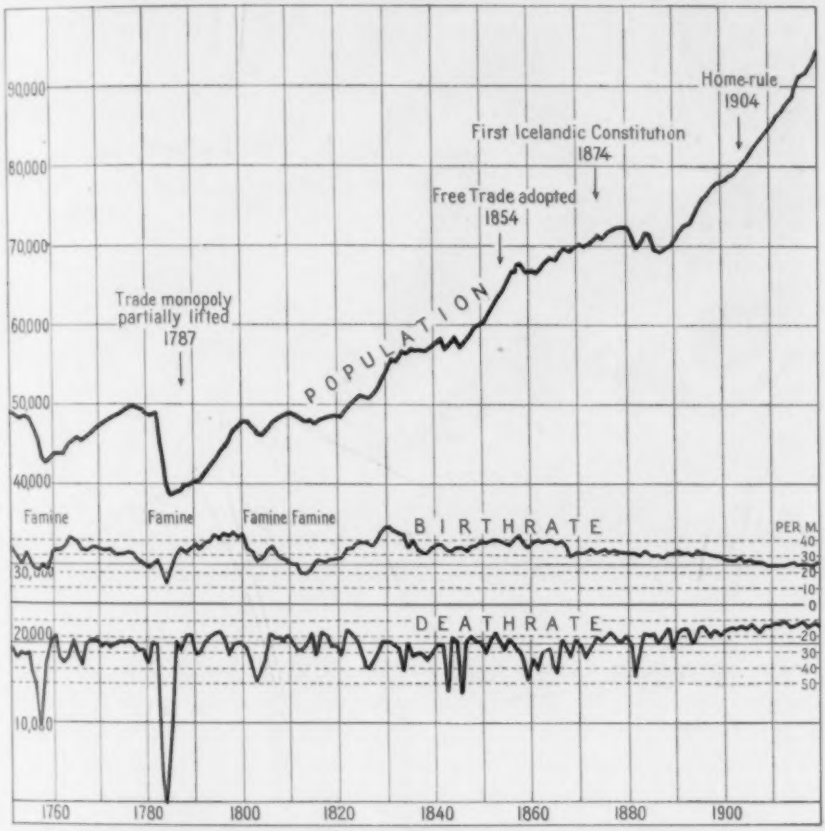


FIG. 2—Graph showing the movement of the Icelandic population from 1751 to 1920. (From Fig. 1 of Gudmundur Hannesson: Körpermasze und Körperproportionen der Isländer, Reyjkavík, 1925.)

So far has the country's spirit progressed in the last century that today the question of imperialism is beginning to show itself. A small but determined group is demanding access to and eventual possession of Greenland. It bases its claims on "historical" as well as "natural" rights—the first centered on the early discovery and colonization of Greenland by Icelanders, the second on the fact that Iceland has more use for the rich Greenland fisheries than has Den-

[8] A summary of the Act of Union is given in Gjerset, *op. cit.*, pp. 449–451, and in "Iceland" pp. 23–25.

mark, these now being withheld for the purpose of protecting some 14,000 Eskimos. All Danish subjects, it should be noted, have equal rights with the Icelanders as far as access to Icelandic fisheries is concerned. In 1918, when the Dano-Icelandic Act of Union was drawn up, the Icelanders protested that this arrangement was more favorable to Denmark than Iceland and requested that the Greenland fisheries be thrown open at least to Danes and Icelanders. In the motifs of the Act is a paragraph stating that this will be done as soon as possible, but that it is impossible under the present conditions.

FIG. 3—Shore crews of large motor boats cleaning fish at Sandgerdi.

CHANGES IN THE TWENTIETH CENTURY

It is held by many that modern Iceland was born with the twentieth century. Certainly most of the visible changes which today distinguish the country from that of two hundred years ago were made in the last twenty-five years. The Bank of Iceland was established in 1902, the telegraphic cable to the British Isles and the European mainland was laid in 1906. The first telegraph line was built about the same time. The building of roads was begun in 1894. The University in Reykjavík was founded in 1911. The Icelandic Steamship Company was established in 1914, and the Icelandic Marine Insurance Company in 1918. Agricultural schools, business schools, marine schools were founded. Trade and commerce boomed. In 1912 there were fifteen wholesale dealers and commission agents in Iceland; in 1923 there were 48. The first permanent daily paper was established in 1911: today there are three dailies, besides eleven weeklies. There are, moreover, quite a number of periodicals, some literary and general, others devoted to special subjects, commercial magazines, an engineering paper, periodicals on fishing and farming, medicine, theology, etc. The splendid harbor works at Reykjavík are of recent origin.

THE ECONOMIC PROGRAM: THE FISHERIES

In an interview with the prime minister of the time, Mr. Jon Thorlaksson, I asked whether the rebuilding of Iceland is being worked

out in accordance with a definite plan, an economic program. The answer was that no such program has been drawn up but that the general trend may be expressed as follows: (1) improvement and expansion of the two main branches of activity—fishery and agriculture; (2) establishment and expansion of foreign commerce with a permanently favorable balance of trade; (3) the possible future establishment of manufacturing industry, utilizing the enormous but hitherto untapped natural resources—water power and natural steam.

TABLE I—COMPOSITION OF THE ICELANDIC FISHING FLEET

YEAR	SAILING VESSELS	MOTOR BOATS OVER 12 TONS	TRAWLERS	OTHER STEAMERS	MOTOR BOATS UNDER 12 TONS	ROWBOATS
1905	165		1	3	1944	
1910	140		6	2	1724	
1915	95	40	20	6	391	1121
1920	39	120	28	2	355	1002
1921	33	124	28	1	340	992
1922	41	140	31	6	354	901

It is natural that the effects should be most immediate as regards the fisheries. After a thousand years of existence Iceland is in many respects just emerging from the pioneer stage. Transportation facilities on land are still lacking. The fishing grounds, however, are immediately accessible. The government's activities are mainly concerned with police, education, and encouragement. Three gunboats patrol the fishing waters in an effort to keep all trawlers and all foreign fishermen outside of the three-mile limit.

One-third of the "profits" of the patrol boats, fines, and proceeds from the sale of confiscated materials are put into a national fund for the promotion of fisheries, a fund which is augmented by direct governmental subsidies. Loans from it are granted for the purchase of vessels and fishing gear and for any kind of improvement in the fishing trade. Sums are granted to young men who desire to study the fishing industry abroad. Certain sums are used for the publication of periodicals that deal with fishing. Others are given out as rewards for exceptional merit. The government, moreover, runs two special schools for sailors and fishermen, one for navigation opened in 1891 and the other for marine engineers opened in 1905.

The changes that have taken place in recent years in the nation's fishing methods are strikingly demonstrated by the accompanying

table. Large motor boats and steam trawlers—the latter constituting nearly two-thirds the total tonnage in 1922—are taking the places of rowboats.

In the movement of population, discussed later, this has a special significance. While fishing has always been one of the chief occupations of the Icelanders, it is now becoming a highly specialized occupa-

FIG. 4—Spreading codfish in the sun to dry. (Photograph by Magnus Olafsson.)

tion. Almost any farmer can fish from a rowboat at certain times of the year, but it takes all of a man's time and energy to belong to the crew of a trawler or a large motor boat. Farming and fishing are definitely being divorced from each other—the latter now calls for concentration of population at the ports and coastal towns, where the catch can be handled, salted, dried, packed, and shipped in large quantities.

An enormous increase in the catches of the last few years is evident in the government statistics. Some fifteen million cod and fish of the cod species were caught in 1900. In 1922 the number had risen to thirty-six million. The herring catch has increased proportionately. In 1923 the export of herring amounted to 19,000 tons, the total export of fish to 59,464 tons.[9] By far the greater part of the fish are exported salted or salted and dried. Some are sent to England packed in ice. Canneries are being talked of: a few were established immediately after the war, at the time of the country's greatest prosperity; but these failed, partly because of inexperience, both in canning and in opening new markets. But there is hardly any doubt that large fish canneries will in the future help to stabilize the export trade.

One extremely interesting phase of the fishing life is the coöpera-

[9] Figures from "Iceland."

tive system employed in connection with the large motor boats engaged in fishing for cod. Ten men comprise the crew of each boat—five belong to the shore crew and five to the boat crew proper. At the coastal fishing stations, each crew of ten lives in one room of a dormitory, sharing the room with a servant-girl who is hired by them to do the cooking.

FIG. 5—Twelve-ton motor boat used extensively for fishing, Reykjavik harbor. Note the modern coal crane in background, built in 1927.

The shore crew cleans fish, boils the livers, etc., and also prepares the lines and baits the hooks. The boat crew goes to sea fourteen to eighteen hours at a time and fishes with set lines. None of the men receives wages. They buy their food coöperatively at the station's store and generally charge the cost until the end of the season. When the season at any one station is closed, the proceeds are divided as follows: the owner of the station receives one-twenty-fifth for the use of docks, sheds, living quarters, etc. The remainder is divided into twenty parts, of which the owner of the boat receives nine, the captain receives two, and each man receives one. The owner of the boat pays for lines and hooks, also for half of the engine oil and half of the bait (generally pieces of fresh herring). The others each pay for one-twentieth of the oil and bait.

The engineer receives his twentieth of the total catch and also has a private line for which he buys the bait and the full proceeds of which go to him. Salt is paid for on the same basis as oil and bait.

The cod liver oil belongs to the men, but the heads go to the owners, who first spread them out to dry and to fertilize the land and later grind them up for fish meal. If prices are low at the end of the season, the men have the option of taking their share in fish instead of money

or of storing the fish on the chance of a rise in prices. In this manner a fisherman may earn anywhere from $70.00 to $700.00 for a season's work.

Promotion of Agriculture

There is as much significance as picturesqueness in the fact that many of the government's agricultural statistics are still expressed in terms of horseloads. The crying need of Icelandic agriculture is

Fig. 6—Icelandic ponies. While in Iceland they are gradually being supplanted by automobiles for travel purposes, they are nevertheless increasing in numbers, owing in part to increasing exportation (see Fig. 15). (Photograph by Olafur Magnússon.)

transportation. Little can be done where the produce must be carried to market on ponyback. There is not a single navigable river in the country. The need is being met as fast as the limited national finances will allow. Some half a million *krónur* a year are being spent on the building and upkeep of bridges and roads. At the beginning of the century the sum was about a hundred thousand. In 1890 there were no cart roads whatever in Iceland; today there are some 1500 kilometers, most of them suitable for automobile traffic and radiating from the principal towns. Only now has construction begun to connect the towns. In six years it will be possible to motor from Reykjavík to Akureyri.

For many years there has been talk of railroads, but the necessary capital has been lacking. A water-power concession was granted last year (1927) to a Norwegian company, with the express stipulation that the company also build a sixty-mile railroad from Reykjavík into Iceland's richest agricultural district. According to the terms of the concession, work on this railroad must be begun by May 1, 1929; but at the present writing the stocks of the company are low, and there is great skepticism in Iceland as to whether or not the road will be built.

The term "agriculture" in Iceland is not to be taken with the same meaning as in more southerly countries. Cereals cannot be

grown. There are no large plowed fields. A clump of houses with a small patch of potatoes and turnips, a fairly large fenced field, manured or fertilized with nitrates and phosphates, growing soft rich hay, and wide, open pasture lands on which the sheep and the horses and the cows can stray far into the hills—that is an Icelandic farm. More often than not the land is broken up by hummocks, the bane of the Icelandic farmer. Machines—tractors—are almost never seen, even horse drawn plows were a rarity until ten years ago, and only now are

FIG. 7—Írafoss, on the Sog River, flowing from Lake Thingvalla. (Photograph by Hans Petersen.)

mowers and wheeled rakes being introduced in those localities where the nature of the ground and the means of the farmers will permit of their use. But if the means are limited, they are being energetically developed. Well over a hundred farmers' coöperative societies now receive government aid for the promotion of agriculture. The government itself runs two agricultural schools and experimental stations and makes direct loans out of the agricultural fund for the improvement of estates and living quarters.

An act of the Althing of 1903 provides for an annual grant of 100,000 *krónur* to be expended on barbed wire fences and thus allow for more intense cultivation of hayfields. For it is in hay and its animal products that the salvation of Icelandic agriculture lies. It is claimed that the rich lowlands of southern Iceland, if properly developed for dairying, could support the entire present population of the country.[10] Coöperative dairies are springing up. Icelandic butter and cheese are finding their way into the British market, where they are meeting with a very favorable reception.

Sheep and horses, through the centuries of the country's isolation, have developed into distinct breeds. Both are small and hardy, a fact which is more to the advantage of the latter than the former. One has but to pick up almost any travel book on Iceland, whether sympathetic to the country or not, to find the horses eulogized.[11]

[10] Gjerset, *op. cit.*, pp. 453–454.

[11] See, for instance, W. S. C. Russell: Iceland: Horseback Tours in Saga Land, Boston, 1914.

FIG. 8

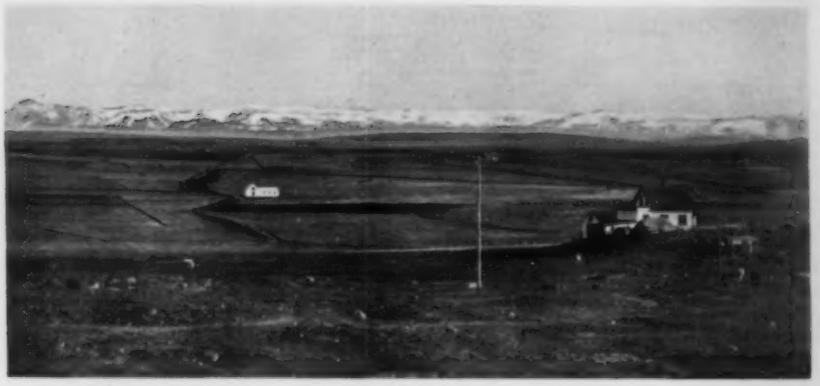


FIG. 9

FIG. 10

FIG. 8—An Icelandic valley. View of Mt. Esja northeast of Reykjavík, from the south.
FIG. 9—The road to Hafnafjördr. View looking south from Reykjavík.
FIG. 10—The town of Hafnafjördr. Reykjavík lies beyond the first ridge.

FIG. 11

FIG. 12

FIG. 13

FIG. 11—Old style farm sheds and buildings.
FIG. 12—Old type farmhouse near Sandgerdi, on the southwestern extremity of Iceland.
FIG. 13—Modern farmhouse near Reykjavík.

A number of horses are exported every year under the careful supervision of a government inspector. During the latter part of the nineteenth century most of them went to England for use in the coal mines. But now, because of the modernization of the mines, the market is shifting to Denmark. It is interesting that Denmark, famous for its own horses, should import Icelandic stock. But the ponies of the latter country are far cheaper both as to first cost and as to upkeep and are extensively used by small Danish holders as draft animals.

But by far the greatest item in the agricultural exports is mutton and sheep products—wool and green-salted sheepskins. The export of mutton, mainly salted, has more than doubled since 1900. Norway is the greatest market for this commodity. But last year the *Bruárfoss* was finished, the latest addition to the fleet of the Icelandic Steamship Company, carrying a complete refrigerating plant which will permit the shipment of frozen meat. This should tend to shift the market. England has large need of fresh foodstuffs.

The breeding of animals for the improvement of stock is one of Iceland's future problems. A beginning was made some years ago, when a few foreign sheep were imported for breeding purposes. Unfortunately they brought some disease with them which raised havoc with the native stock, causing the experiment to be abandoned. As far as the vegetable products of agriculture are concerned, there is a tremendous amount of work to be done.

One peculiar problem is that of the hummocks, which are found on almost every farm in the country and make the use of harvesting machinery, mowers, rakes, etc., virtually impossible. These hummocks have been described in detail by Thoroddsen.[12] They represent one phase of a phenomenon occurring in subarctic and arctic regions and due primarily to the alternation of freezing and thawing in a cold climate.[13] There is some agitation in Iceland for a fund to be used for study of the problem. Farmers spend years in leveling their fields, only to have the hummocks spring up again a few seasons later. They can be leveled by machinery, but this requires heavy plows and tractors.

Another problem to which the government is turning its attention is that of reclaiming land. Originally the Icelandic hills were supposed to have been covered with "forests," principally of scrub birch three or four feet high such as are still found in certain spots. These are said to have been destroyed by the sheep, which were allowed to roam all winter and gnawed the bark off the trees when the ground was covered with snow.[14] When the trees died, the soil was washed away

[12] Thorvaldur Thoroddsen: The Botany of Iceland, Part I, 2: An Account of the Physical Geography of Iceland with Special Reference to the Plant Life, Copenhagen and London, 1914, pp. 261–264.

[13] Leonard Hawkes: Frost Action in Superficial Deposits, Iceland, *Geol. Mag.*, Vol. 61, 1924, pp. 509–513. Note the excellent illustration on Pl. 27, facing p. 513. See also J. S. Huxley and N. E. Odell: Notes on Surface Markings in Spitsbergen, *Geogr. Journ.*, Vol. 63, 1924, pp. 207–229.

[14] A view held by many Icelanders and expressed to me by Mr. Sigurdr Sigurdsson, one of the leading agriculturists of the country.

or covered with sand. Today thousands of *krónur* are being spent, both for reforestation and reclamation of land through irrigation.

One extremely interesting phase of Icelandic agriculture in which beginnings have recently been made is irrigation for warmth, using the numberless hot springs. The average potato crop alone can be

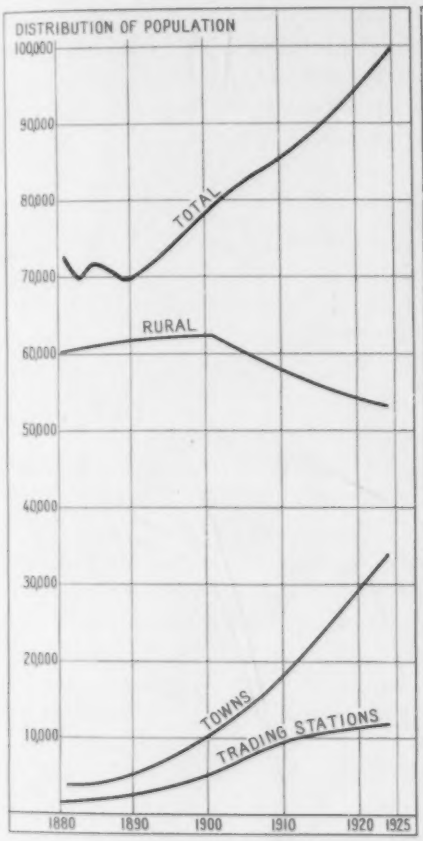


FIG. 14

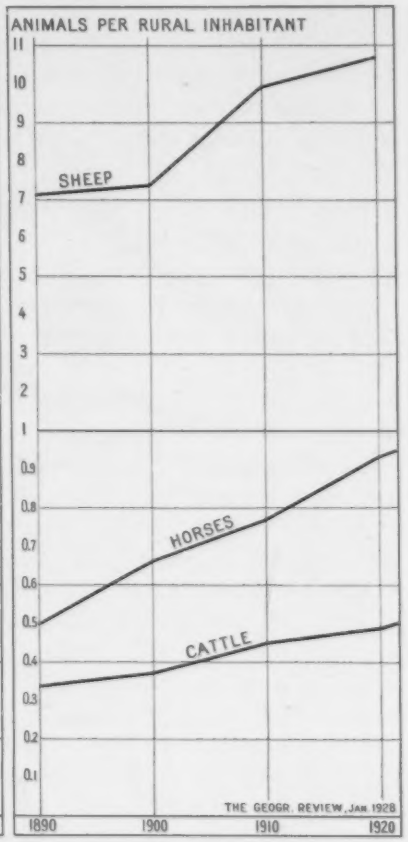


FIG. 15

FIG. 14—Graph showing the recent growth of the Icelandic population distinction being made between urban and rural.

FIG. 15—Graph showing the per capita increase of live stock on Icelandic farms. Compare the curve for rural population in Figure 14. Figures from government statistics.

doubled in this way, both because of the artificial lengthening of the season and also because of the protection given against summer frosts. And by combining the use of warm springs with hothouses almost any of the common kinds of vegetables can be raised. One farmer near Reykjavík is making a fortune by sending his hothouse products to that city, which has to get nearly all of its fresh vegetables from the European mainland. A friend who spent last summer in Iceland,

tells me that he saw spinach, cauliflower, and cabbage grown on the north coast, without the use of hothouses or warm springs. His visit was fortunately timed as the farmers did not know what to do with the spinach and had to be shown how to cook it.[15]

Progress in agriculture, however, has barely begun. Even today over two million kilos of potatoes and some 400,000 kilos of milk and dairy products are being imported annually. These figures should be cut enormously with the establishment of better distribution facilities and the improvement of agricultural methods. Artificial fertilizers, for instance, were not introduced until 1921. Today some 500 tons a year of nitrates and phosphates are being imported.

Commerce

In 1900 Iceland had an average annual export of about $20.00 per inhabitant. Today the figure is more than six times that amount, among the largest in the world. The import trade is slightly less. Thirty years ago two steamers, of about three-hundred tons capacity, made regular runs between the mainland and Iceland. Today there are nine, ranging in size from 800 to 1500 tons, and the number of tramp freighters has increased in proportion.

The exports, to which reference has already been made, are fairly simple in character. They consist of fish and fish products, farm products, mutton, wool, hides, live sheep, live horses, and a small amount of dairy products. The imports consist of practically everything used by a civilized people. And the commerce has only begun to grow. Given normal conditions it should again be tripled in the next two decades. The farmers are rapidly improving their standard of living as their isolation is broken down. For centuries Icelandic farmers were content to use dried sheep manure as their only fuel. Coal and even peat had to be transported on ponyback and hence were expensive. The annual or semiannual caravans to town had enough to do to carry necessities and liquor. But along the motor roads coal is becoming indispensable. It is the same with furniture, with clothing, with building materials, and with radio tubes.

The principal nations for trade are Denmark, Great Britain, and Spain. The latter, a Catholic country with a ready market for fish, is by far the greatest single buyer of Icelandic exports. Denmark has up to now been the leading seller of imports, mainly through force of a habit developed for centuries. But in 1924, for the first time in history, Great Britain had the lion's share of the nation's trade. This is only logical. Trade with Denmark means to a large extent trade through Danish agents. Denmark is an agricultural country and has little use for Icelandic exports. England is crying for food-

[15] See also J. W. Harshberger: The Gardens of the Faeroes, Iceland, and Greenland, *Geogr. Rev.*, Vol. 14, 1924, pp. 404–415.

stuffs and produces a great many of the things Iceland must buy—coal, machinery, clothing, etc. Indeed, the future prosperity of Iceland is completely tied up with the British Isles. It is there the country's dairy products are sold; it is there that wool is sold; and fresh meat and fresh fish will be sent also when a fleet of refrigerator steamers gets into service.

Not only for commercial purposes do the Icelanders look to England, but for protection as well. No treaty has ever been drawn up between the powers guaranteeing Icelandic neutrality, but as long as Great Britain remains the mistress of the sea Iceland feels secure. The little island country has a fine strategic position in the North Atlantic, and it is to England's interest to see that no foreign power gets a foothold there. More than a hundred years ago, when the Danish adventurer, Jørgen Jørgensen, declared himself king of Iceland and proclaimed the country's independence from Denmark, it was a British and not a Danish man-of-war which put in at Reykjavík and carried him off under arrest on a technical charge.[16]

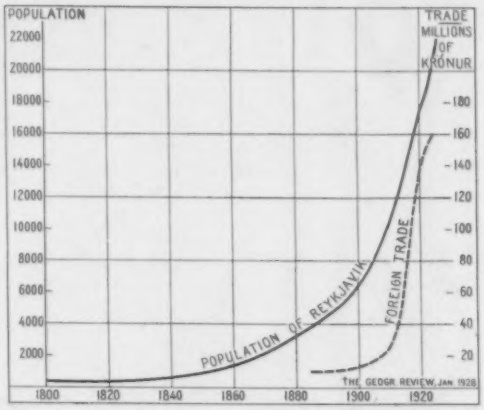


FIG. 16—Graph showing the growth of Reykjavík since the beginning of the nineteenth century and the recent development of Icelandic foreign trade. Figures from government statistics.

PROSPECTS OF MANUFACTURING INDUSTRY

The small variety in Iceland's exports places the country in a precarious position. Its prosperity varies with the price that Spain pays for fish. Let the price of fish go down and all the business men complain of hard times. Indeed, they claim that their country is a Spanish dependency. The prohibition law in Iceland was revoked at the command of the Spanish merchants. Only by allowing wines with up to 21 per cent alcohol into the country could an agreement be made with the Spanish government lifting a tariff on fish which would have been ruinous to Iceland.

The Icelanders are turning their hopes to manufacturing industry. At first glance it looks absurd that this handful of people with no raw materials of their own should become a manufacturing people. It is not so. Iceland has almost unlimited water power. The river Thjorsá

[16] Gjerset, *op. cit.*, p. 354. Also a contemporary account is given by Sir George Stewart Mackenzie in "Travels in the Island of Iceland . . . . ," 2nd edit., Edinburgh, 1812.

alone can be developed to the extent of a million horse power. Between three and four times that amount are available in the other rivers. Where power is cheap, raw materials can be imported.

In Iceland, however, while a great deal can be done toward converting the country's present products, weaving wool textiles, canning fish, etc., the immediate industrial prospects fall into a different class. Any large-scale industry must be of a nature requiring little man

FIG. 17—Street in modern Reykjavík.

power. The Icelanders are too few in number to support large woolen mills and too careful to protect their national life to permit the importation of large bodies of foreign workmen. This narrows the industrial possibilities down to electro-chemical conversion, either of nitrates or aluminum. Neither requires extensive man power, and both are more dependent on cheap electric power than on the price of raw materials. Nitrates can be made out of thin air; aluminum deposits of commercial value are found in Iceland, otherwise so poor in mineral resources.[17]

Icelandic industry is as yet only in the speculative stages. When the country does become an industrial nation it will have unique and interesting technical problems to offer. No spot in the world gives the engineer a better opportunity to experiment with the utilization of volcanic heat. The Icelanders are watching with tremendous interest Italy's natural steam power plant at Lardarello, Tuscany. They themselves are making a good beginning in the use of the hot springs. Several farms are heated with natural hot water. A small woolen mill near Reykjavík pipes a hot spring into the building and

[17] A large bauxite deposit was found in the northwestern part of the country last year. On sending a sample of it to England, the owner immediately received an order for 500 tons.

uses it entirely for heating and drying. A large national hospital and two schools now under construction in Reykjavík will be heated entirely by this means. Iceland's coal bill could be cut enormously through more complete utilization of the hot water which is on hand in unlimited quantities. The possibility of heating the whole city of Reykjavík with water from the hot springs at Hengill, some fifty kilometers away, has been discussed.[18] The scheme is visionary as far

FIG. 18

FIG. 19

FIG. 18—Reykjavík's evolution in building. The oldest house in the city, contrasted with one of the newest.
FIG. 19—Einar Jonsson's museum of modern Icelandic sculpture.

as practical application is concerned; Reykjavík will have to be half again as large as it is before it is economically feasible. But the idea is there.

TOURIST INDUSTRY

The tourist industry offers tremendous and immediate possibilities for the country. Tourists today are ever on the lookout for the unusual. There is little doubt that in a short time, when adequate facilities for their reception and housing are on hand and when Icelanders have learned more about the arts of propaganda and advertising, the country will be overrun by travelers, attracted no less by the impressive scenery and the fine clear air than by the romantic name. Even today almost every boat from England during the summer season is crowded with British visitors, drawn in part by curiosity and in part by the sporting lure of the rich trout and salmon rivers. As a health resort, too, rivaling and surpassing the most

[18] Jón Porláksson: Hitaveita Reykjavíkur. *Timarit verkfraedingafjelags Islands*, Vol. 11, 1926, pp. 41–44.

famous of European baths, Iceland has great possibilities through its numberless hot sulphur springs.

Population and Movement

Iceland is by far the most sparsely populated country of Europe. With a population of 100,000 and an area of 40,000 square miles, it has a population density of about 2.5 per square mile. In this figure, however, a sharp differentiation must be made between the average and the effective density. About 31,000 square miles of the interior are uninhabited and for the most part uninhabitable, because of glaciers, lava fields, and barren sands. This leaves 9000 square miles for 100,000 inhabitants, or an effective density of 11.1, about the same as that of North Dakota and Nebraska today and of North Carolina in 1810. The small population constitutes a formidable problem in Iceland's economic development. For a great many years, up to the time of reaching the saturation point, the country's productiveness can be increased at a much faster rate than the population. Internal transportation, railroads, and highways pay returns, direct and indirect, in almost direct proportion to the density of population served.

Table II—Distribution of Population According to Occupation

Occupation	Numbers		Per Cent	
	1880	1920	1880	1920
Farming	53,000	43,800	73.2	46.2
Fisheries	8,700	18,700	12.0	19.8
Handicraft and industry	1,500	11,200	2.1	11.8
Commerce and communication	2,600	12,700	3.6	13.4
Total	65,800	86,400	90.9	91.2

But if Iceland is underpopulated, immigrants are by no means welcome. The country's population is increasing at the rate of 1.14 per cent a year. In 70 years it will be doubled. The Icelanders feel that their country must be held open and made ready for its future inhabitants. In the forward steps they are taking they are concerned with their own well-being and with that of their descendants, not with the glory of the nation. In the parliamentary debates concerning water-power concession and industrial development one can see the fear of large bodies of foreign workmen coming into the country to the danger of Iceland's national life. The Norwegian Titans Company received permission to import a limited number of laborers for the purpose of building the railroad on the express stipulation that they be taken out again when the work is done.

We witness in Iceland the amazing growth of the cities, especially of Reykjavík (Fig. 16). The Icelandic cities have come home. A hundred years ago they were on the European mainland—Copenhagen and other Danish cities and, to a certain extent, Hamburg and London were performing the city functions of the nation. Reykjavík a hundred years ago was a trading post of three hundred inhabitants. Today, with its 22,000 inhabitants, it contains about one-fourth of the population of the whole country. Iceland, too, has its movement away from the farms. The cities with their higher wages and their more comfortable life, their motion pictures and cafés, are drawing the population in increasing numbers. Figures 2 and 14 show graphically the movement of population. Table II gives a picture of the "occupational" movement.[19]

The increase among those engaged in commerce and communication is probably the most significant as far as the national life of the nation is concerned. It not only signifies the readjustment in the whole economic structure but demonstrates the creation of and the movement to the "white-collar" class of jobs as well.

If the Icelanders are intelligently bent on their country's progress they are also intelligently aware of the evils thereof. For these, apparently, there is no cure at present. Periodic labor discontent comes with specialization of occupations. Class divisions and class struggles arise when a nation becomes organized for efficiency. All of these have faintly begun to show themselves.

The cultural life of the nation also is undergoing a profound change. A revival in art, sculpture, painting, literature has sprung up, to be sure;[20] but the cultural life of the masses is deteriorating. In the country the necessity for reading, which brought about such a widespread knowledge of Iceland's classics and history, is disappearing as the farms lose their isolation. The radio, the telephone, the automobile, the motion pictures in the cities, and trading posts are doing away with the long evenings of fifty years ago, when the housefather gathered his family and servants around him and read aloud from the sagas. Soon it will be impossible to see a child of twelve or thirteen studying botany from a Latin treatise for recreation.[21] Education for a purpose produces far different results than education for its own sake.

[19] From "Iceland."

[20] Godmundur Kamban: Modern Iceland, *Geogr. Rev.*, Vol. 5, 1918, pp. 195–207.

[21] Russell, Iceland, p. 125.

SOME GEOGRAPHIC ASPECTS OF CUBAN SOILS*

Hugh Hammond Bennett

U. S. Bureau of Chemistry and Soils

[With separate map, Pl. II, facing p. 80]

PROBABLY in no other country of the world has soil character had stronger influence upon national welfare than in Cuba. The wealth of the island has been derived directly and almost wholly from its varied soils. The red lands were taken up first because of their good productivity and easy cultivation, and upon these many fortunes have been made and much good citizenry bred. But there are other favorable types, and if the land has produced largely in the past it is susceptible of great increase both in amount and range of products.

While agricultural operations coincident with the huge production of cane sugar and with the other crops has extended over a very large part of Cuba's better lands, there still remains some arable soil that has never been touched, chiefly in the eastern provinces, the Isle of Pines, and in parts of the western province of Pinar del Rio. The greater part of the cultivated land consists of clay, and large areas of this are of such heaviness that intensive treatment is essential for good yields. Many thousands of acres in cane represent stump land that has never known a plow. On the more easily tilled sandy lands of the west and the widely distributed savanas the chief problem of production is that of artificial fertilization, since these lands generally are of low natural productivity.

As it is, Cuba imports far too much of her food supply—in 1924 to the value of over $100,000,000. She should supply her own needs and expand her exports, considering her favorable climate and available soils. This article deals primarily with the latter asset. The kinds and distribution of soils are shown in generalized form in Figure 1, the first soil map of Cuba to be published.[1] Brief discussions of topographical relations and of some agricultural implications follow.

General Topographic Features

In traveling by rail from the western city of Pinar del Rio eastward through Rincon, Guines, Jovellanos, Santa Clara, Ciego de

*This paper is based chiefly upon data collected by the author and R. V. Allison of the Tropical Plant Research Foundation in carrying out a reconnaissance survey of the soils and agriculture of Cuba, during 1925 and 1926, as a coöperative project between the Soils Bureau, U. S. Department of Agriculture, and the Tropical Plant Research Foundation.

[1] A more detailed soil map of Cuba by the author and R. V. Allison will accompany a report in course of publication by the Tropical Plant Research Foundation.

FIG. 1

FIG. 2

FIG. 1—A typical rural scene along the base of the Organ Mountains near San Diego de los Baños.
FIG. 2—An intensively cultivated stream valley in the central part of the Province of Pinar del Rio. The crop is tobacco.

Avila, Camagüey, and Victoria de las Tunas to Alto Cedro in the province of Oriente, very little but flat and gently rolling country is crossed. There are a few hills, such as those in south-central Habana Province, and some rolling areas, as those between the city of Santa Clara and the Jatibónico River and in the eastern part of Camagüey. About 300 miles of this journey is over flat or nearly flat country. In the central part of the Province of Matanzas the surface is flat from the north coast of the island to the south coast, with probably no point much higher than 100 feet. Again, the whole transverse section of the island from a line some miles west of Ciego de Avila eastward nearly to the city of Camagüey is very largely flat, although varying locally to gently rolling, with an occasional isolated hill or small group of hills.

Aside from the great mountain massifs of eastern Cuba, areas of strong relief are restricted principally to the highlands of Pinar del Rio, the Trinidad Mountains, the Holguin Hills, and the broken line of hills extending along the north coast. Except for the hills and mountains in Santa Clara, the southern two-thirds of this major part of the island consists very largely of flat country. On the eastern side of the extensive flat belt reaching from Manzanillo near the Cauto River across the Alto Cedro Plain to Nipe Bay on the Atlantic, approximately 80 per cent of the country is mountainous and hilly, with many peaks rising to 3000 feet and one to 8000.

Altogether about three-fifths of the island is flat to gently rolling and admirably adapted, so far as topography is concerned, to the use of any kind of farm machinery. Some rather extensive belts consist of marshland, such as that found in the peat bogs of Zapata, where it is difficult even to walk on the soft, water-soaked material. Also, considerable areas of flat, heavy clay land become so hard on drying that powerful tractors or cable plows are necessary to effect satisfactory deep tillage; while still other tracts comprise rocky land with very little soil. Additional extensive flattish and undulating areas consist of thin savana land and lean, shallow soil having little value except for the pasturage afforded.

The remaining two-fifths of the country consists of strongly rolling hilly and mountainous land, of which probably one-half is arable although some of the cultivable portion consists of steep slopes where continuous cultivation eventually would be followed by wasteful erosion.

In summing up it may be said that the minimum area topographically and otherwise suitable for cropping appears to be in the neighborhood of 52 per cent of the island, or nearly 23,000 square miles. Not all of this consists of high-grade farm lands, although the greater part is good soil or can be made good soil by proper treatment. A further extension of the area of farm land may be found possible

through the utilization of some of the well-drained areas of thin soil and stony land for the production of henequen (sisal).

The areas of rougher surface do not, however, represent waste land only; some is forested, other tracts can be brought into forest, while a considerable part has value for grazing.

Many of the smaller streams flowing toward the sea never reach it but become clogged of channel in the broad coastal lowlands, spreading over the expansive flats to add to the accumulation of water from rain falling directly on the surface. Thus large tracts of coastal plain are inundated for long periods during the rainy season, causing damage to crops and preventing timely cultivation. Much coastal plain land of this kind has been left in forest or is used only for pasturing stock.

In the red lands dominating the plains of Camagüey and of Ciego de Avila, streams are of very infrequent occurrence and are generally without water in the dry season except where they have their sources on the higher-lying watersheds. One area of 500 square miles in southeastern Matanzas Province has not a single streamway throughout its entire extent. The red soil, although composed largely of clay, is so porous that practically all of the rain falling on it passes rapidly downward into the ground with little or no run-off. There are openings, or sink holes, here and there, through which some water sinks into the basal limestone; but most of the rainfall, amounting to approximately 70 inches, passes directly into and through the soil, which has the high pore space so characteristic of well weathered tropical clays. Part of this water travels by underground streams, known as *sumideros*, into the sea where it is forced up through salt water to form the fresh-water "boils" or ocean "springs" at short distances offshore. Sometimes after continuous heavy rains, underground water, flowing in reverse direction under pressure from

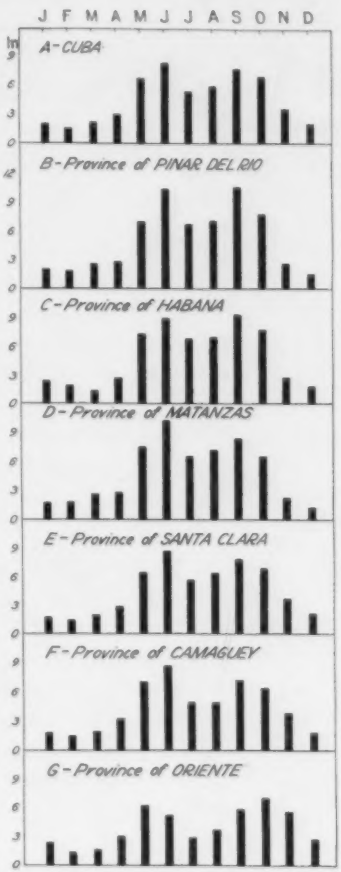

J F M A M J J A S O N D
A-CUBA
B-Province of PINAR DEL RIO
C-Province of HABANA
D-Province of MATANZAS
E-Province of SANTA CLARA
F-Province of CAMAGUEY
G-Province of ORIENTE

FIG. 3—Average monthly rainfall of Cuba (1899–1924), reproduced from O. L. Fassig: Rainfall and Temperature of Cuba, *Tropical Plant Research Foundation Bull. No. 1*, 1925. "In all provinces there is a minimum rainfall in January or February with a steady increase to a maximum in May or June, followed by a decrease in July, with a secondary maximum in September or October."

FIG. 4—Blocklike monoliths of cave-riddled limestone (*mogotes*), Viñales Valley section of the Guaniguanicos, western Cuba. Some of these strange masses of limestone rise to more than a thousand feet from the floor of the valley.

higher areas, boils up through the ground by way of these subterranean passages. In Camagüey Province during the heavy rains of the summer of 1926, water boils of this nature are reported to have broken through the dirt floors of some of the native houses.

Drainage of these low wet lands is one of the major problems confronting the improvement of many thousands of acres now being used for sugar cane, with none too good results. A few canals already have been dug on several plantations, but practically nothing has been done in the way of establishing large and properly coördinated drainage districts.

Some Special Features: The Guaniguanicos

The Guaniguanico Mountains, comprising the western part of the highlands of Pinar del Rio, are worthy of special mention because of their unusual topographic features. They rise from a smoothly undulating plain in the form of huge blocks and mesas, known as *magotes*, to a maximum height of about a thousand or twelve hundred feet above the supporting floor. The plain lies considerably below the enclosing strips of piedmont hills, having attained this position through the more rapid dissolution and removal of the basal limestone than has taken place in the resistant schists and other crystallines of the hill country to the north and south. From these higher piedmont positions one looks down upon a beautiful valley, a prodigious sunken garden. The limestone monoliths rising abruptly from the valley floor, with almost perpendicular walls, have a remarkable likeness to artificial structures. In places deep defiles separate the *magotes*, giving the appearance of a city of castles. At close range the great monoliths are seen to be riddled with caverns and lesser openings.

Stalactites descend from overhanging ledges and from the roofs of caves; the face of the cliffs is vertically streaked with white lime precipitate from dripping waters. Ceibas, with their green trunks, grow fantastically on shelving positions and in cracks where there are small accumulations of disintegrated rock and soil, and royal palms form a narrow fringe of forest along the immediate base of the cliffs. The mountain sides and tops, however, largely consist of bare rock.

The *magotes* undoubtedly owe their block-like form to the tumbling in of the roofs of caverns and the spans of natural bridges. Natural bridges were observed in several parts of the system, as well as the remnants of bridges which had caved in. In time the remaining masses of these picturesque highlands will succumb to the undermining that already has honeycombed them to their very heart, and finally there will be left a normal limestone valley lying between ridges of schist rocks that once were the foothills of the limestone range now disappearing. But this is not going to take place immediately, and in the meantime here is to be seen a unique orographic feature of the

Fig. 4—Blocklike monoliths of cave-riddled limestone (*magotes*), Viñales Valley section of the Guaniguanicos, western Cuba. Some of these strange masses of limestone rise to more than a thousand feet from the floor of the valley.

western hemisphere; indeed, there probably are not many places in the world where this type of mountain exists. In the southern part of the Malay Peninsula there is a similar chain of monolithic limestone highlands.[2]

It seems strange that so magnificent a spectacle as the *magotes* of the natural sunken garden called Viñales Valley are seldom visited by Americans living almost within a stone's throw. Apparently few

FIG. 5—A swamp of royal palm and dense undergrowth of water-loving plants in the western projection of Zapata Swamp.

outsiders have even heard of the region or of the many other charming features of western Cuba: its delightful valleys, the grotesque bottle palms, the clean bright towns and cities, where nearly every house has its frontal row of Grecian columns, the pleasant sunshine of winter, and a landscape dotted with colorful tobacco farms.

ISLE OF PINES

The northern part of the Isle of Pines consists of a peneplain developed on schist rocks of a highly quartzose character, some ranging to pure quartz schist. The surface is flat to gently rolling, with some hills in which the country rock has been but slightly altered. Some of the lower flats along the coast and the streams have been formed of material washed out of the higher areas of schist-derived soils. These correspond closely to the more poorly drained types of the flatwoods areas of the southeastern United States. Predominantly, however, the soils of the higher positions are sandy loams with a high content of

[2] J. B. Scrivenor: The Physical Geography of the Southern Part of the Malay Peninsula. *Geogr. Rev.*, Vol. 11, 1921, pp. 351–371.

quartz and schist fragments. Light-colored sandy soils, with cover of pine, palmetto, and wire grass, they resemble the sandy lands of Florida and are responsible for the statements sometimes heard to the effect that the Isle of Pines is a bit of Florida transplanted to the Caribbean. The comparison is sound only in the superficial resemblance; for the soils, the dominant types, are markedly unlike those of Florida in their origin and actual characteristics, and the vegetation includes

FIG. 6—Bottle palms on sandy soil of the Caribbean coastal plain, Pinar del Rio. Leaves partly stripped off for roofing tobacco-curing barns.

a considerable number of plants not found in Florida, such as the bottle palm and several tropical hardwoods. On the other hand, in being well drained and sandy the crop adaptations correspond to those of better-drained sandy lands of the Florida Peninsula, and their low natural fertility, as in Florida, calls for liberal fertilizer treatment.

These sandy lands of the Isle of Pines correspond in origin to much of the soil found in the piedmont areas of western Cuba. They are usually deeper, however, and much better suited to agricultural utilization, such as the growing of vegetables and grapefruit.

Rising above the sandy peneplain constituting the northern part of the island are a number of high limestone peaks. These stand above the smooth plains in striking conspicuousness. The southern part of the island, that lying south of Lanier Swamp, is mostly shallow limestone soil and bare *piedra hueca*, holey rock, so called from its cavernous nature.

Coastal Plain of Western Cuba

The coastal plain strips of western Cuba, the areas lying to the west of the red lands belt, are markedly unlike the coastal plain areas

in other parts of the country in that the soils are very largely sandy; whereas in central and eastern Cuba the low coastal lands are principally occupied by heavy clays.

These western sandy lands, formed of material washed out of the piedmont areas, correspond for the most part with the soils of the coastal plain regions of the southeastern United States. Most of the types have their duplicate in the latter country, although several have never been identified therein. Much of the soil used in growing the finest cigar leaf produced in the Vuelta Abajo tobacco district consists of the Greenville, Orangeburg, and Ruston fine sandy loams, all of which are of abundant occurrence in southeastern United States.

There is a considerable stretch of flatwoods country southwest of Guane that corresponds in every respect with much of the flatwoods of the Florida Peninsula, having precisely the same soils, the same vegetation of pine, palmetto, and wire grass, and even the shallow lakes and intermittent lakes so common to the latter region.

The Zapata Peninsula Region

This division, situated largely in the southwestern part of Santa Clara Province, consists principally of swamp land, together with some important areas of rocky limestone land, where there is little or no visible soil. The swamp consists of peat bog and soft, whitish marl, both covered with water or saturated throughout the year. Both types of swamp support two principal kinds of vegetation: timber and open glades of saw grass. The latter predominates, but there are important forests of mixed hardwoods along the inner border, and there are fringes of mangrove near the sea and along waterways. In many places the peat is more than five feet deep and is entirely too boggy for use as pasture land. The marl also is deep, soft, and mirey. The Zapata Swamp essentially duplicates the characteristics of the Florida Everglades.

Cost of drainage will militate against reclamation in this region, at least until the less swampy higher-lying areas have been used.

The stony areas are honeycombed with cavities in which there is soil for plants that have their beginning in shallow surface accumulations of soil, disintegrated rock, or leaves. Roots straying out from these find their way through the holes and into sufficient soil to support, in some places, a fair type of forest.

The Nipe Mountains

The Nipe Mountains, ranging from about 2000 to 3000 feet in elevation, comprise the western extension of the great eastern mountain massif. They are of interest chiefly because of the deep beds of red soil or iron ore covering the smoother parts of the summit. In

FIG. 7

FIG. 8

FIG. 7—Orange grove on Matanzas clay at Ceballos, Province of Camagüey. Fruit of excellent quality is produced in this locality, both with and without irrigation.

FIG. 8—Pine lands and mixed hardwoods of Nipe Mountains. In the background an extensive burned-over area. Squatter farmers operate on small clearings of limestone slopes (see Fig. 9). (Photograph by Matthews and Crosby.)

places the rock from which the soil has been formed, mainly serpentine, has decomposed to depths of 50 feet or more; and so complete has been the weathering that the soil has lost nearly all its elements of plant food as well as most of its silica. Much of the material contains less than three per cent of silica, only traces of lime and phosphorus, and but little magnesia. On the other hand, iron is present in amounts up to 70 per cent or more, and alumina up to 18 per cent. In other words, this is severely weathered or laterite soil, too poor for crop production. It is so exceedingly porous that nearly all of the rain passes down through it as fast as it falls, and there is practically no erosion. Although of high clay content, the material is very friable. Pine forest and scattering coarse grass are present.

FIG. 9—Bananas and plantains on squatter clearing in Nipe Mountains. This very steep slope of thin limestone soil will suffer from erosion after a few years of cultivation. (Photograph by Matthews and Crosby.)

THE VEGETATIVE COVERING

Fairly heavy timber originally covered the lowlands of the island except the savanas and the excessively stony areas and peat bogs. The abundant mangrove swamps of the islands (keys) and the low clay lands immediately along the coast support small trees having but little present value, save for charcoal and tobacco poles. A few exceptionally dry localities of limited extent, such as that of the lower Guantánamo Valley, support only small trees, stunted palms, cacti, and semi-desert bush growth. There are pine-covered tracts in Pinar del Rio, on the Nipe Mountains of eastern Cuba, and over the greater part of the Isle of Pines. Fairly heavy timber is found over considerable stretches of the eastern mountains. On the other hand, great areas of mountain country are so stony that as a rule only small trees are found. A peculiar vegetative condition prevails on some of the areas of *piedra hueca*. On the large tract of this kind found

FIG. 10

FIG. 11

FIG. 10—*Piedra hueca* soil: Coralline limestone with numerous cavities. The roots of plants find sustenance in soil hidden in the holes that penetrate the rock.

FIG. 11—Exceedingly stony (limestone) hill land of this kind produces fair crops of sugar cane if the dry season is not too prolonged and fertilizer is used. It will produce good plantains and excellent henequen (sisal)

on Zapata Peninsula, huge silk-cotton trees (ceibas) are to be seen in places where no soil whatever is visible, and there are many other species of trees of fair to good size. Here plants find sustenance in soil that is hidden in the deep holes that ramify the rock.

The native lowland forest varies considerably, according to drainage and soil. Certain species which are very abundant on the imperfectly drained black and brown clays of the *Bayamo* soil group are rare or altogether wanting on the perfectly drained red clay of the *Matanzas* type. Locally, royal palm is plentiful on both well drained and swampy clay soil and is one of the characteristic features of the landscape over most of the country; however, over some types of clay land it is entirely absent and on the savanas and the poorer sandy lands it is usually absent.

Hardwoods are found in large numbers through the heavier forests, and there are also numerous soft species. It is stated that some two hundred hardwoods are indigenous to Cuba. Most of these are put to some use by the natives. After seeing in Havana and some of the other cities excellent furniture and doors of finely carved mahogany, it is a shock to find that this beautiful cabinet wood has not only been used very extensively for crossties and ordinary construction purposes but has even been burned on a very large scale in the clearings made for sugar cane. Many plantations have done away with all or nearly all of their valuable forests in the madding haste to extend their cane plantings or bring up the yield by taking new land into cultivation. Relatively more of the timber has been saved recently, on account of scarcity of wood. In 1926, however, the writer heard of "good burns" on freshly cleared land and saw hundreds of acres of valuable wood go up in smoke.

There is immediate need on the part of the nation, as well as many large sugar centrals, of getting under way reforestation projects on abandoned areas and on certain good timber soils that are giving ridiculously low yields of cane. One or two plantations recently have developed plans for reforesting some of their lands.

The charcoal burners have been berated as destroyers of timber. This charge in most instances is unjustified, since these operators confine their activities chiefly to isolated swampy and rocky coastal areas, where there is but little really good merchantable timber. Furthermore, they do not annihilate the forests as the large agriculturists have done but leave many small trees for rejuvenation of closely cut-over tracts.

The savana areas, because of infertile sandy soil and shallow clay over rock, are largely covered with grasses, palmettos, bushes, and small trees. These areas generally are much better suited for live stock than for crops. Large and widely scattered tracts having no crop value whatever afford at least fair grazing.

Cuba an Agricultural Nation

After a few days of travel through the provinces east of Pinar del Rio, one gains the impression that Cuba is a prodigious sugar-cane field, with some local interruptions represented by tobacco fields and patches of corn, plantains, beans, and vegetables. Tobacco is an important sale crop, but the area devoted to it is small compared with that of the cane fields.

The extent to which the island is agricultural in its activities is indicated by the value of exports presented in Table I.

Table I—Value of Cuban Exports for 1924*

Product	Value	Per Cent of Total Value of Exports
Raw sugar, molasses, and other products of sugar cane	$384,643,000	88.4
Tobacco and tobacco products	39,406,000	9.1
Fruits and vegetables	5,202,000	1.2
Forest products and textile fibers	726,000	.2
Animal products, etc.	2,118,000	.5
Mineral products, sponges, etc.	2,770,000	.6
Total	$434,865,000	

*Comercio Exterior, Secretaria de Hacienda, Cuba, 1924.

Production of Cuban raw sugar for the 1924–1925 crop amounted to nearly a third of the world's output of cane sugar for that year, or 5,125,970 long tons, against a world tonnage of 15,561,092.[3] The rapid extension of the area devoted to the crop during the last quarter century has brought the gross output of sugar to a point where it is doubtful if any other important country can equal its record, at this time, in point of agricultural specialization upon a single crop.[4]

Some Aspects of the Sugar Cane Industry

It is generally recognized that the fabrication side of the industry has kept efficient pace with the steady increase in the available supply of raw materials from the fields during this period of huge expansion. From the agricultural standpoint, however, the situation is different. Extensive rather than intensive methods have prevailed. The fact that sugar is really produced in the field rather than in the mill has been lost sight of on many of the great centrals, and primitive and inefficient methods are in wide use, both in the cultivation and in

[3] Story of Sugar in Hawaii, Hawaiian Sugar Planters' Association, Honolulu, 1926.

[4] Compare R. H. Whitbeck: Geographical Relations in the Development of Cuban Agriculture, *Geogr. Rev.*, Vol. 12, 1922, pp. 223–240.

the selection of land for planting. When the yields have run down, especially on the plantations of the newer regions of the eastern provinces, it has been the custom to throw the land out of cultivation and to clear and plant new land. This planting has been done by sticking the seed in holes punched into the unplowed stump land with a sharpened stick or crowbar.

No attempt has been made to select the better lands. The savana areas have generally been avoided, it is true, but this about covers the limit of soil selection according to crop adaptability. Even in 1926, to give an example, some large plantings were made on an old plantation in one of the middle provinces, on a site where toxic salts whose presence had not been ascertained in advance by the management, killed the cane in its infancy.

The low acreage yield of sugar in Cuba is due to a variety of causes, some of the most important of which, at least from the cultural side of the equation, are: (1) The use of too much inferior soil, (2) inadequate preparation of the fields before planting, (3) failure to cultivate and control weeds in too many fields after planting, (4) failure to refreshen with fertilizers long-used fields on certain impoverished but not "worn out" lands, and (5) failure to remedy the imperfect drainage of lowlands by adequate canaling and ditching. Plant diseases, insects, and sometimes droughts take toll of the crop also; but these deterrents constitute problems that often cannot be controlled so readily as the phases of land usage and cultivation mentioned. Recent studies have shown that in many instances damage charged to root diseases is actually of a non-pathogenic nature, representing simply unfavorable soil conditions such as can be remedied in many cases by proper cultivation or drainage.[5]

A survey of the soil situation in Cuba by the soil-type method shows conclusively that a large increase in the average yield of cane can be brought about by extensive reorganization of the fields for the purpose of taking out of cultivation certain inferior soils and turning these to use for pasture or timber. The ills of the Cuban cane grower are not going to be remedied by tenacious adherence to old methods on impoverished land or on inferior new land, nor is there going to be relief for all through the magic of fertilizers indiscriminately applied. Some of the old methods of cultivation are good under certain conditions, and the use of fertilizers of the right kind in the right place and in the right way will contribute considerably toward a betterment of yield; but they can never take the place of needed tillage and drainage.

It is contended by some growers that their sugar mills must be kept grinding at capacity. It is obvious, however, that the milling season should be shortened if going through the full season means that

[5] J. A. Faris and R. V. Allison: Sugar Cane Root Disease in Cuba, *Phytopathology*, Vol. 17, 1927.

much cane from poor fields is to be converted into sugar at a loss. It is common knowledge that some centrals strive for tonnage output with too little regard for cost. In order to break last year's record or to exceed the output of some rival mill (rival in the sense of output only), cane is frequently brought from other plantations, transported at high freight costs, and finally milled at a loss. Practices of the kind are reported as being due in some instances to the psychological

FIG. 12—This field of cane has not been replanted for 80 years and is still producing good crops. It is on rich alluvial soil.

effect high tonnage output has upon those who have to do with the financial obligations of the plantations. Such a situation, of course, is merely an unfortunate one, without real geographic or economic basis.

NEED FOR BETTER SOIL USAGE

In undertaking to deal with the varied soils according to their specific needs and adaptations, it is first necessary that they be accurately classified and defined. Without this information there will be continued confusion as to soil identity in outlining and controlling farm management practices; virtual impossibility on some farms of correctly utilizing the results of fertilizer, tillage, and varietal tests that may be carried out upon the important soils of the island; and frequent uncertainty in the matter of deciding what is and what is not pasture or forest land rather than cane land.

Two examples will be given of widespread misjudgment of soil needs in Cuba and the costly results of such ignorance. A considerable number of plantations are carrying on deep plowing and knifing with steam cable plows on soils of the very extensive *Bayamo* group, which types have at or near the surface of the ground heavy, putty-like clay that is exceedingly plastic and sticky when wet. This disturbed material with a few soaking rains flows back to its original state

of density, so that the effects of the expensive tillage are completely obliterated, save where troublesome *paraná* (Pará) grass has been destroyed by the operation. Such a soil in southeastern Santa Clara Province, which had been knifed and cross-knifed to a depth of about 30 inches and then plowed to 18 inches, gave a crop of plant cane that

FIG. 13

FIG. 14

FIG. 13—Vegetation on stiff clay savana, where the salt content is rather high. The tall tree is the very common *Palma cana*, closely resembling the cabbage palmetto of Florida.

FIG. 14—Corojo palms on semi-savana of rather low productivity in central Cuba. This thorny species produces an edible fruit, and its leaves are used as a textile.

was not worth cutting, while the cost of tillage had been approximately $60 per acre.

In case of clays of the soils of the *Truffin* group opposite conditions prevail. When moist, this clay is moderately friable; on drying, the subsoil assumes a condition of hardness that is almost stone-like. Extreme desiccation takes place after the rains have ceased. By the latter part of the dry season no active moisture can be detected down to depths of four or five feet, as a rule; and as a result young cane parches severely. Only a few planters have learned that deep knifing in the dry state shatters the hardened subsoil clay to form a permeable subsoil condition favorable to storage and retention of moisture.

FIG. 15

FIG. 16

FIG. 17

FIG. 15—Pine, *paralejo* bushes, and wire grass on the thin soil of the piedmont region in western Cuba. Cordillera de Guaniguanico in background.

FIG. 16—Savana of extraordinarily intractible black clay that defies efficient cultivation and is best adapted to grazing.

FIG. 17—Sandy coastal savana, very poor soil for cropping, but producing considerable grass (*espartilla*). The palmettos are known as *juta de Guanabacoa*.

With this sort of treatment these clays, at least temporarily, can be converted into what amounts to a new soil type, one that gives three, four, or five times the yield of cane. How long the effects of this good treatment will last has not been definitely determined, but it is known that several good ratoon crops can be counted on where the work is effectively done. In 1926 cane was harvested from thousands of fields including this kind of land, often where the yield was not more then five or six tons an acre, or scarcely enough to pay the cost of cutting and hauling it to the mill.

It is not to be understood that all of Cuba's cane lands consist of these unfavorable clays. Actually there are extensive types of exceedingly desirable sugar-cane soil, such as the deep friable clays of black, brown, and red color: *Camagüey*, *Santa Clara*, *Matanzas*, and other types. These give excellent yields wherever weeds are properly controlled. The vast flat plains of friable red clay of the Matanzas type, representing one of the most extensive soils of the island, have been in cultivation for several generations throughout Habana and Matanzas Provinces. Some fields which have been in cultivation for a hundred years are still producing 15 or 20 tons of cane per acre, although fertilizer or manure has never been applied to some of the areas.

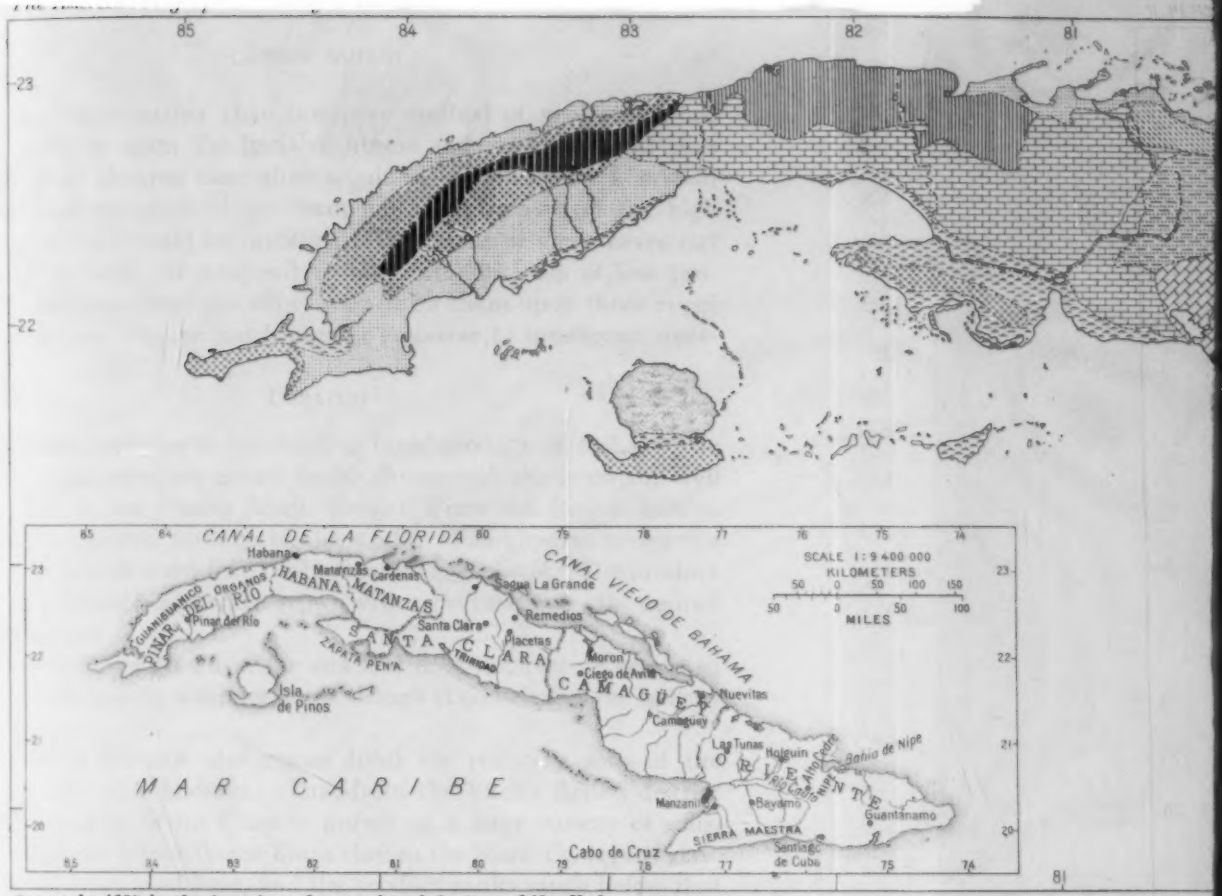
These red lands are truly remarkable. The soils often extend to depths of 20 feet or more without visible change in their physical make-up and show essentially no change from the surface down, either chemically or physically, when submitted to analysis. There is so little stickiness that plowing can be done within a few hours after torrential rains. There is very little run-off, and practically no erosion, even on slopes.[6]

It should be explained that this is one of those peculiar tropical soils, of low silica content and high iron and alumina content, in which the clay particles have come together in floccules, or clusters of grains, in such a way as to give rise to abundant pore space for the passage of water.[7] In the Nipe Mountains of eastern Cuba a deep red serpentine-derived soil of high clay content is nearly as friable as sand and seems to be not in the least susceptible to erosion. It has been so leached that practically all its constituents have disappeared with the exception of iron, alumina, and a little silica, manganese, chromium, and nickel. The type is extraordinarily unproductive as a soil but it is valuable as iron ore. It does grow pine trees and wire grass, however.

Some planters undertake to justify the poor condition of cultivation obtaining on many of the Cuban sugar estates by pointing out

[6] H. H. Bennett: Agriculture in Central America, *Annals Assn. of Amer. Geogrs.*, Vol. 16, 1926, pp. 63–84.

[7] H. H. Bennett: Some Comparisons of the Properties of Humid-Tropical and Humid-Temperate American Soils, *Soil Science*, Vol. 21, 1926, pp. 349–374.



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1. Coastal Plains. Mainly flat and frequently merging into swamp; much land inundated in wet season. Large variety of soils chiefly clays of stiff, impervious subsoils: brown over yellow (*Jucaro*); brown over yellow, gray, and red (*Herrera*); black over yellow (*Zapata*); and *Truffin*. In northwestern Camagüey much stiff, gray alluvial clay (*Yaguajay*); in northeastern Camagüey and northwestern Oriente much black and gray clay over greenish, stiff clay (*Lugareño* and *Tunas*); in northwestern Oriente considerable brown, friable clay of purplish cast (*Chaparra*). The *Chaparra* is nearly all in cane, giving good yields: other clays often have hummocky surface (hogwallow), difficult to keep in good tilth. Much cane grown with rather poor yields on the *Jucaro*, *Herrera*, and *Zapata*, and also on local salty areas. In Pinar del Rio flat and often wet near sea; undulating to rolling and well drained toward interior. Predominantly sandy and gravelly soils of acid reaction and low fertility. Many types like those of southeastern United States. The better drained of these, especially those with reddish, friable sandy clay subsoils (*Greenville*, *Orangeburg*, *Ruston*, and *Pinar del Rio*), produce with fertilizers a fine grade of tobacco. Some good cane on alluvial soils. Considerable hardwood forest locally in east. Some infertile savanas.

2. Limestone red lands. Mainly flat plains. Deep, red clay (*Matanzas*); friable and highly permeable; little change from surface downward. Excellent soil, largely used for sugar cane. Locally shallow and stony, better suited to pasture. Considerable red and brown clays (*Perico* and *Truffin*) with tough clay subsoils, highly desiccated and stone-like in the dry season, but on which yields can be greatly increased by deep subsoil tillage.

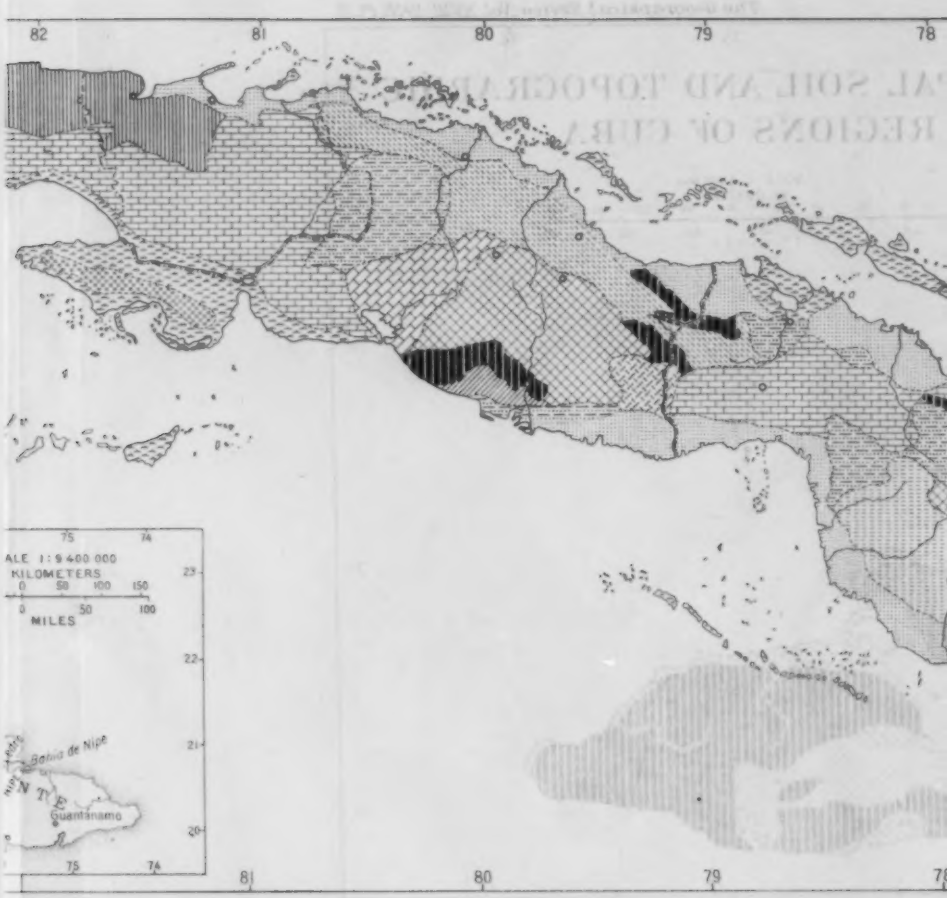
3. Rio Cauto-Alto Cedro Plain. Low and flat; some areas imperfectly drained. Mostly heavy clay of black (*Bayamo*) and gray (*Alto Cedro*) color, difficult to keep in good tilth. Extensively used for cane. Some limestone hills, consisting chiefly of *Santa Clara* soils. In places injurious amounts of salt.

4. Savanas. Flat, locally undulating. Mainly grass, with palms and small trees locally abundant. Sandy soils and shallow clay over rock, usually of low productivity. Liberally fertilized, well-drained deep sandy lands (*Estrella types*) produce fair crops of cane. The dominant shallow soils, including the peculiar *Mocarrero* sandy types with ironstone hardpan, best suited to grazing: henequen probably could be grown. Little cultivation except on associated patches of limestone. Many small savanas not shown.

5. Sandy peneplain, northern part Isle of Pines. Mainly grayish, acid sandy soils, locally containing abundance of angular quartz, over yellow and red clay (*Santa Barbara*); brown sandy soils, with abundance of iron concretions over reddish and yellowish clay (*Nueva Gerona*). Well drained, giving good results with citrus fruits where fertilized. Vegetables grown commercially on moister flats. Vegetation chiefly pine and palmettos. Basal rocks largely quartz schist: several isolated limestone mountains and schist hills.

6. Southern Interior Camagüey Plain. Flattish to undulating, with low isolated hills. Some flats covered with water in wet season, but generally fair to good drainage. Principal soils: black clay over chalk (*Oriente*), black clay over yellow, limey clay (*Camagüey*), and *Santa Clara*, *Truffin*, and *Matanzas* clays. On the hills some gravelly and stony *Habana* and *Matanzas* clays. Much good cane land. Considerable hardwood forest in places.

7. Trinidad Plain. Undulating to rolling, with some hills. Well drained, with considerable good soil extensively used for cane. Predominantly brown clay loam over yellow clay, with gravel and soft sedimentary lime rock beneath (*Palmarita*); chocolate-colored clay and clay loam over red, friable clay, representing old alluvium on benches (*Caracusey*); *Santa Clara* clay and stony clay on the higher positions.



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8. Guantanamo Valley Region. Undulating and rolling with some hills; good drainage. In western part, chiefly brown clay and clay loam overlying interbedded sandstone, conglomerate, and chalky lime (*Palma* types), with considerable *Santa Clara*, *Habana*, and stony clay. In eastern part chiefly brown clay overlying greenish clay derived from greenish shale, with considerable good alluvial soil. Much good cane land. Exceptionally dry climate about Guantanamo Bay; some desert vegetation.

9. Gently rolling to hilly. Well-drained brown (*Santa Clara*), ashy-gray (*Habana*), black (*Camagüey*), and red (*Matanzas*) limestone clays. Locally shallow and stony. Deeper types of smoother areas productive and extensively used for sugar cane and locally for tobacco. Some quite stony areas of *Havana* clay produce good cane.

10. Sagua-Moron rolling to hilly. Chiefly *Habana*, *Matanzas*, *Santa Clara*, *Truffin*, and *Camagüey* clays, gravelly clays, and stony clays. Some exceedingly stony hills in north-central Santa Clara Province. Soils highly varied. Many deep favorable areas used for cane. Much tobacco grown in *Remedios* district on all types of clay, including quite stony lands. Considerable stony land best suited to pasture.

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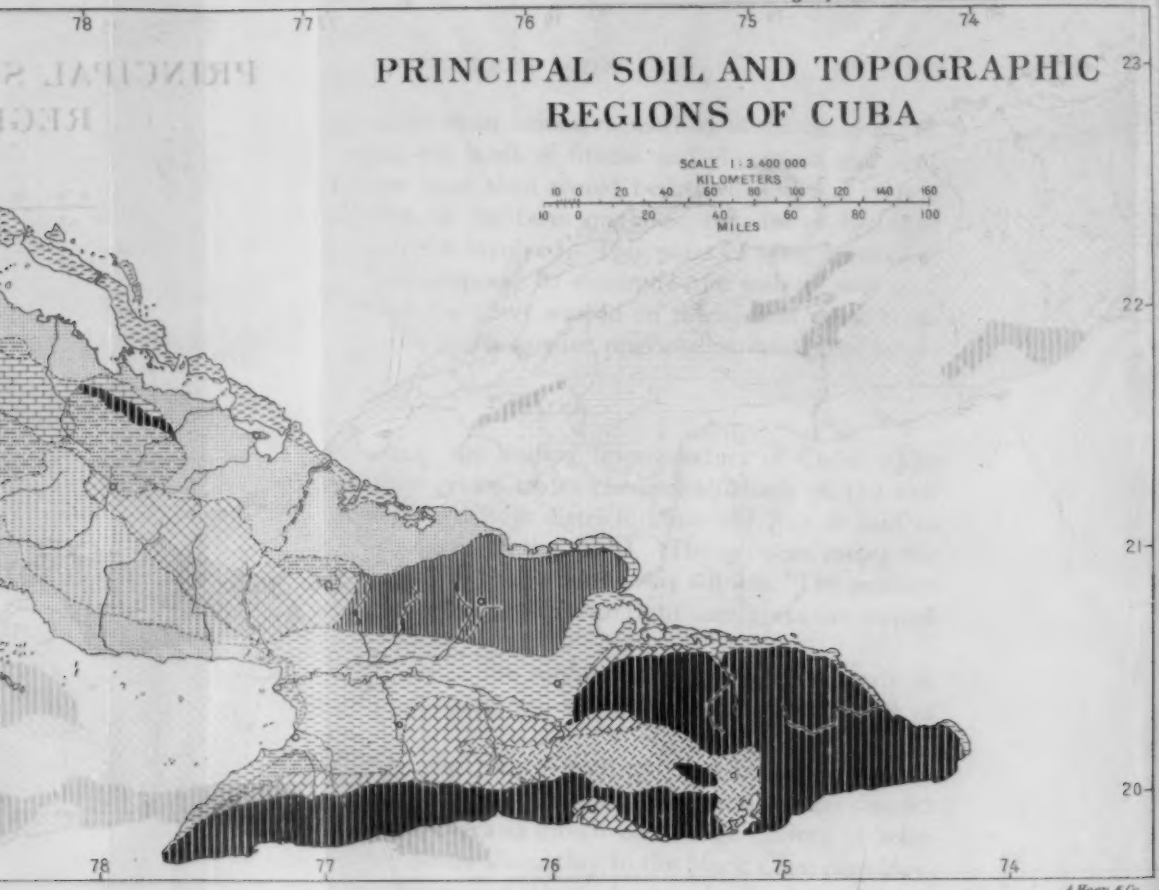
PRINCIPAL SOIL AND TOPOGRAPHIC REGIONS OF CUBA



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11. Gently rolling to hilly. Well-drained brown (*La Largo*) and red (*Limones*) clays derived from igneous s, chiefly serpentine, hard when dry. other areas of deeper soil produce fairly l cane. Some heavy tobacco grown. y shallow and stony areas, now farmed, low yields and should be turned to ure. Cattle raising very important in agüey-Las Tunas area.

12. Foothills or Piedmont Region of Western Cuba. Rolling to hilly peneplain of thin gravelly and sandy of low productivity. Little used except pasture. Pine and wire grass. Tobacco alluvial soils. Some isolated hills, 1500 elevation.

13. Habana-Matanzas Hill Region. Higher elevations 900 to 950 feet altitude. Mainly *Habana*, *La Largo*, *ones*, *Matanzas*, and *Truffin* clays and stony s. Considerable deep soil locally, on which to good sugar cane is grown. Some king and dairy farming. Stony areas erally used for pastures. Some stony soil he *Habana* type used for fruit, while some eedingly stony land of the *Matanzas* type es good yields of henequen.

14. Holguin Hill Region. Shallow, gravelly, and stony land underlain by sedimentary and igneous (mostly serpentine) rocks. Much rolling land with deeper soil derived from limestone and serpentine. The more stony soils, as the red serpentine clay (*Holguin*) and the shallower (*Matanzas*, *La Largo* and *Limones*) types, droughty, of low crop value, and best suited for pasture, although henequen might be introduced. Some good cane on deeper soils and fair yields from occasional limey gravelly areas. Some very poor savana, with chalk near the surface and thick growth of palm. Region exceedingly variable in soil, topography, and agricultural value.

15. Mountains, including Maestra Range (maximum elevation about 8000 feet); the great massif of extreme eastern Cuba, including Nipe and other mountains; Trinidad Mountains; Organ Range; Guaniguanicos. These highlands are rough and include much excessively stony and steeply sloping land of value only for forestry. Many strips in valleys and coves and patches on shouldering positions cultivated by small farmers. The deep, friable, red serpentine soil of the Nipe Mountains, mined for iron ore, is exceedingly poor but supports pine forest and wire grass. In parts of the eastern mountains considerable hardwood forest.

16. Piedra Hueca. Shallow soil over cavernous limestone. Mainly forested and only useful for timber.

17. Swamp Lands. Chiefly mangrove swamp (saline clay); deep and shallow peat, as in Zapata Peninsula region, and marl. Peat and marl areas support mainly a growth of saw grass. Permanently saturated and very little used except for wood cut for charcoal.

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that the extensive rather than intensive method of production has survived entirely upon the basis of fitness and cheapness and that this plan gives cheaper cane than would be grown under a system involving modernization of the farm methods, because of the high cost of labor that would be involved. This point of view leaves out of account entirely the proposal to eliminate the soils of low productivity and to expend the effort wasted on them upon those types which are known to give much greater response to intelligent treatment.

Tobacco

After cane, tobacco is the leading farm product of Cuba. The high-grade cigar wrapper grown under cheesecloth shade on the well drained land in the Vuelta Abajo district, Pinar del Rio, is said to be the highest-priced tobacco of the world. The growers prefer the quartzose soils with a reddish, friable sandy clay subsoil. The product from these selected lands, when grown with right care, gives the desired taste and aroma.

Filler tobacco is grown in the sun and does not receive nearly so much attention as the wrapper, even though it constitutes the bulk of a finished cigar.

Some good tobacco also comes from the red clay soils of the Partito district near Habana. That from the Vuelta Arriba district in the province of Santa Clara is grown on a large variety of soils, ranging from the brown *Santa Clara* clay to the black *Camagüey* clay. Fertilizers are not used here, and the product ranks much below that of the more westerly districts, namely, the Partito and Vuelta Abajo.

Other Products and Agricultural Possibilities

Much market gardening is carried on in the environs of the cities and towns, but commercial trucking is restricted. Peppers, eggplants, tomatoes, and lima beans are shipped to New York during midwinter from the sandy lands of the Isle of Pines and from two or three points west of Habana, while some potatoes are shipped from the red lands of southeastern Habana Province. Excellent crops are grown on the well-drained sandy soils of Pinar del Rio and the *Matanzas* red clay north of Ciego de Avila and in a few other localities. There is abundant opportunity for increasing the midwinter shipment of these products. Good grapefruit comes from the Isle of Pines, and oranges of excellent quality come from the red clay of Ceballos and from several other localities. Bananas are exported from the coastal region east of Nipe Bay in far-eastern Cuba.

Henequen is grown commercially on exceedingly stony land near the cities of Matanzas and Cardenas; from this a large amount of cordage is locally manufactured for domestic consumption, and some

fiber is exported. There is no good reason why the nation should be content to see the production of this valuable crop restricted to these two localities, when precisely the same soil and other conditions as those obtaining where the crop is now being grown so successfully are to be found over extensive unused areas in other parts of the island.

But for the long dry season and high labor cost, Pará rubber probably could be successfully grown. The trees would thrive on a number of the moist types of friable subsoil character occurring in several parts of the island. On the red soils of the *Matanzas* group, Pará rubber trees would luxuriate under irrigation. These lands are rather droughty, however; and, without artificial watering, flow of latex might be sparing in the dry season.

Cacao and coffee, formerly extensively grown, have fallen to positions of little importance. Within comparatively recent times cacao groves have been cut down and planted to sugar cane. There still are some small *cafetals* in the mountains, producing for local consumption. If the mountain coffee is as good as it is declared to be—and some contend it equals the Blue Mountain variety of Jamaica—there would seem to be possibilities for making this an important crop for export and domestic use.

There are many reasons why Cuba should diversify her crops in a really substantial way. As we have already said, the soils are available and the climate is favorable; furthermore, the Cuban on the farm is a good worker, and the need is very great. Much land that is not suitable for cane, although being used for that crop, should immediately be turned over to increased cattle and hog production as the first important move toward a more balanced type of agriculture. Hogs are very easily raised. The royal palm alone produces enough fruit, an excellent hog feed, largely to increase the production of pork and lard. In addition, corn, sweet potatoes, cassava, and the tropical yam—all of which can be grown easily and abundantly nearly everywhere—could be used very advantageously in connection with increased hog production. Also, Cuba is a good cattle country. Most of the cane crop is carted out of the fields with Cuban bulls. In some localities the raising of cattle for beef has attained large importance, and dairying is of significance near Habana and the other larger cities. Grass and forage crops can be grown nearly everywhere, and rather easily. There appear to be good opportunities for building up an export trade in cattle with Central America and possibly Mexico and parts of the West Indies.

As the writer sees it, the possibility of establishing for Cuba a new economic equilibrium based upon an improved type of agriculture constitutes one of the most attractive and important scientific problems to be found anywhere in the field of agricultural development today.

AN UNNOTICED ANCIENT METROPOLIS OF ASIA MINOR

H. H. von der Osten

Hittite Expedition of the Oriental Institute, University of Chicago

FIG. 1—The ridge of Kevkenes Dagh from the east, crowned by the unknown ancient city. From right to left the elevations are: Keykavus Kaleh, the citadel; Kiramitlik; Gös Baba.

THE "unnoticed metropolis" of this paper is a remarkable site, the existence of which has long been known but which has apparently never been described. Yet it is the site of the largest pre-Greek city of Asia Minor, a city that in its day must have been one of the chief cultural and political centers of the great Hittite Empire that flourished in the second millennium before the Christian era. In the last few years the decipherment of Hittite cuneiform records has greatly stimulated our interest in that Empire and its mysterious and little-known people.[1] Its survivals, however, cover a vast territory, scattered as they are from one end of Asia Minor to the other, and little has heretofore been done to recover and study them.

In the summer of 1926 the Oriental Institute of the University of Chicago began a campaign of research in the field. The first step was the making of a preliminary archeological survey in the basin of the ancient Halys River, the Küzül Irmak[2] of today.

FIRST VIEW OF THE CITY ON THE KEVKENES DAGH

One evening during the course of the preliminary explorations of 1926 on our way back to Yozgad we passed a remarkable site which appears on Kiepert's map of Asia Minor[3] simply as a mountain called Kjerkjanos Dagh, our Kevkenes Dagh, with nothing to indicate the imposing ruins awaiting us. The inhabitants of the village at the foot

[1] For a summary of our present knowledge of the Hittite Empire see H. H. von der Osten: Explorations in Hittite Asia Minor, *Oriental Institute Communications No. 2*, Univ. of Chicago Press, 1927. See also D. G. Hogarth: The Hittites of Asia Minor, in: The Cambridge Ancient History, Vol. 2, 1924, pp. 252–274.

[2] Turkish names transliterated according to the system now being worked out by the Oriental Institute.

[3] Karte von Kleinasien, 1:400,000, Berlin, 1902–1906.

of the mountain told of a *büyük kaleh*, big castle, at its summit and a *chŏk büyük sur*, very big wall, reaching from the castle itself to Kiramatlik, "the place where there is pottery," a still higher point in the lofty mountain ridge nearly 1.5 kilometers southward (Figs. 1 and 5). Though it was already late we climbed up to the "castle," whence we had a comprehensive view of the wide plateau between the two elevations just mentioned, the entire plateau being surrounded by the ruins of what must have been a great wall built of large stones. The place was of such magnitude and importance, and the interval before sundown so brief, that we abandoned any thought of even a sketchy survey, promising ourselves to return the following year.

FIG. 2—The general location of the ancient city of which the citadel is now known as Keykavus Kaleh.

Our first year's investigation in the region had made so obvious the need of systematic archeological work that the General Education Board granted an appropriation for the support of a five years' campaign of Hittite research in Asia Minor.[4] In pursuit of these plans the Institute selected for excavation in 1927 an unidentified but extensive site near Alishar, about 128 miles (205 kilometers) east-southeast of Angora, in the heart of the Hittite country, and not far from the ancient capital, now known from the name of the neighboring modern village as Boghaz Köi (see Fig. 2). The necessary concession for excavation was granted by the Angora Government, which throughout has shown a spirit of cordial coöperation, and the expedition established itself in the field late in May. From Alishar it was possible to make excursions to neighboring sites and ruins noticed or discovered during the preliminary work of the preceding summer. Among these was a visit to the site on the Kevkenes Dagh, which was undertaken at the first opportunity.

SECOND VISIT TO KEVKENES DAGH

Accompanied by Mr. Erich Schmidt, of our staff, and Tachsin Bey, our Turkish dragoman, I traveled over the road taken the year before towards the impressive ridge of the Kevkenes Dagh. The Anatolian sun, usually so brilliant, was hiding behind a screen of black clouds from which rain was descending upon the villages in the distance, a fact which unfortunately interfered with our photographic record. We passed through Karavilly, one of those pleasant, clean,

[4] Additional support for the first year was also contributed by a group of interested friends: Mrs. Murray Crane, Mr. Henry J. Patten, Mr. James A. Patten, and Mr. Frank G. Logan.

flat-roofed little Anatolian villages, which came to life at our approach. Ragged little brown children came tumbling out of the gates, and among other strange characters appeared a *hodja*, the village priest and teacher, who alone is still permitted to wear the fez and turban. Our curiosity was roused by a peculiar long, flat rock resting on two smaller

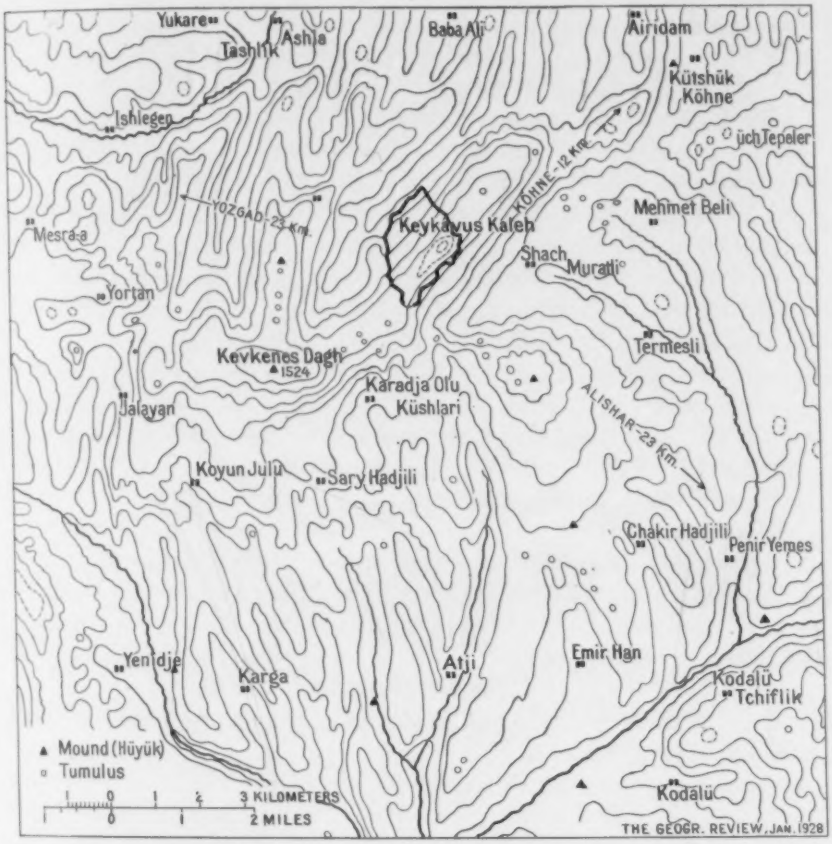

FIG. 3—Sketch map showing the site of the ancient city in relation to neighboring antiquities and modern villages.

ones—we had seen similar rocks in nearly every village. Tachsin Bey informed us that this is the "death stone" of the village, upon which are laid the bodies of the dead before their burial.

In the next village, Kerbiyeh, we sought in vain the explanation for the pear-shaped lava rocks resting on the corners of certain roofs, and also employed as gravestones. We had observed similar stones in other villages. Their meaning still remains a mystery to us. At Yazili Tash ("inscribed stone"), the next village, we rephotographed the late-classical architrave we had seen the year before. Halfway between Yazili Tash and the village of Penir Yemes ("there is no

cheese"), a good-sized ancient city mound called by the natives Chadür Hüyük ("the tent-shaped *hüyük*," mound) is visible from the road. After passing Termesli we reached Shach Muratli, a village at the foot of the long mountain range on which was situated our goal.

Half an hour's hard climb over slippery rocks and grass brought us to the ancient city enclosure, beyond which we continued to climb until we reached the top of the *kaleh*, some forty meters higher (Fig. 4). From this point the panorama is impressive. One looks far over the city and across the surrounding plains. To the west, toward Yozgad, and to the north is a mountain landscape, the higher peaks being surmounted by tumuli. Southward lies the irregularly divided plateau upon which is situated the larger part of the ancient city we had come to survey, stretching out to the elevation of Kiramitlik, behind which is visible the large tumulus of Gös Baba ("eye-father"), perched on the southernmost tip of the Kevkenes Dagh. Still farther southward and eastward extends the wide and fertile plain through which flows the Konak Su with its many tributaries. Hundreds of villages dot the plain and the hills with their groups of flat-roofed houses huddled together. The villages nearer at hand are clearly visible, but those at a distance stand out by reason of the groves of trees among which they nestle, such groves in this region being found only near human settlements.

Numerous tumuli can be observed on the mountains as well as on the slopes of the Kevkenes Dagh and on smaller elevations in the plain, where I could also distinguish at least five ancient city mounds (Fig. 3). From the plain, about twenty-three kilometers away, emerges the Sivri ("points"), a steep mountain, near which one could discern the site of our own *hüyük* and excavations. Limiting the view beyond the plain to the east lie the Chomak Dagh and a range of high mountains, with groups of tumuli near Terzili Hammam; while to the southeast also may be seen a large part of the high plateau south of the Konak Su, with the tumuli near Battal and the city mound of Sarnen Ören. And finally, far away beyond all these, almost floating in the clouds, rises the vast pyramid of Erdjas Dagh (Mt. Argaeus) near Kaisariyeh, its peak snow-capped.

As to the silent ancient city immediately before us, it is nothing short of imposing. The surrounding walls, which when viewed from the *kaleh* at the easternmost angle of the city appear like long welts of piled-up rocks, enclose an area approximately three times the size of Boghaz Köi,[5] the ancient Hittite capital. The great expanse of ruins, once a city teeming with the life and resounding with the voices of a powerful people who dominated most of Asia Minor, now lies mute and barren. A few scrub trees, stunted by the harsh winter winds

[5] See Otto Puchstein: Boghasköi, die Bauwerke, Leipzig, 1912, Pl. 1. The north-south length of the enclosure of Boghaz Köi is about 1450 meters, and the greatest width east and west about 1150 meters. The area is shaped roughly like a shield.

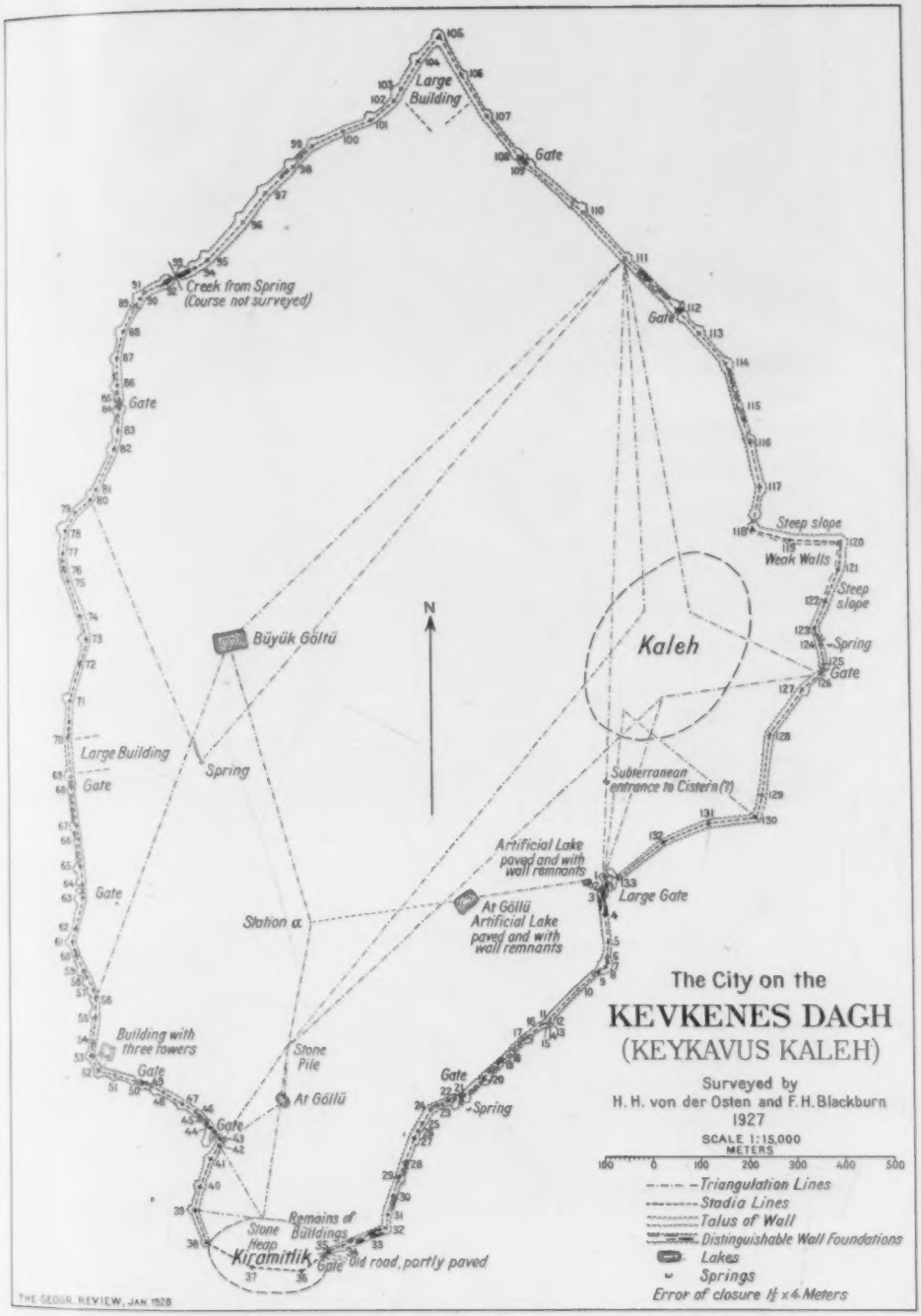

FIG. 4—Map of the main enclosure of the city on the Kevkenes Dagh.

FIG. 5

FIG. 6

FIG. 7

FIG. 5—The ancient city from the east, with the village of Shach Muratli at its foot.
FIG. 6—Looking southeast along the northeast wall from station 106 to station 111.
FIG. 7—Ruins of gate in the west wall at stations 84 and 85.

FIG. 8

FIG. 9

FIG. 10

FIG. 8—Gate in the east wall at station 112.
FIG. 9—The western wall near station 76.
FIG. 10—The present widespread condition of the fallen walls on the west of the city, as seen from station 71.

which sweep over this now deforested region, timidly sprout from amongst the jumble of rocks at the base of the *kaleh* immediately below us. Otherwise the great enclosure is a picture of desolation. Northwest from the steep *kaleh* the ribbon of tumbled wall stretches away in gentle undulations until it reaches what was the northernmost limit of the city (see Fig. 4, station 105; also Fig. 6), where it turns back sharply upon itself southwestwards, and from the *kaleh* can be

FIG. 11

FIG. 12

FIG. 11—Stone pavement on the slope of the citadel (Kaleh).
FIG. 12—Example of the east wall near station 112. It rests on a massive stone foundation.

seen, almost a mile away, continuing southward until it reaches the abrupt, steep slope of Kiramitlik which for a short distance serves to break its continuity (stations 35 to 38). East of Kiramitlik, the city's southern limit, the wall is resumed, winding sharply northward again toward the *kaleh*, to complete an enclosure nearly a mile in width and over a mile and a half in length (1520 meters by 2564 meters).

The enclosure walls follow the natural elevations rising from the plateau; and within them well-marked contours of ancient structures are visible, although here and there at higher points the bed rock comes to the surface. On the *kaleh* itself room divisions are well defined by rectangular lines, once building walls but now simply piles of stones. In some places can still be seen remnants of the actual walls, with stones still *in situ*, the thickness of the wall at such points measuring about 1.85 meters.

SURVEY OF THE RUINS

We selected a place which would be suitable for our tent when we later returned for the survey and took some preliminary notes to

assist us in this latter task. Returning a week later accompanied by Mr. Frank H. Blackburn of our staff at the Alishar excavations, we were able after three days of hard work to map the main enclosure of the great city and make the necessary notes.

The survey of the wall was achieved by "shooting" 133 stadia lines. At each station thus secured the width and height of the fallen wall was measured, as well as the dimensions of any other adjacent construction. The height of the now fallen wall averaged 2.50 meters,

FIG. 13—Artificial lake basin (at Göllü) inside the city wall. Part of the ancient water system.

sometimes attaining 3.50 meters, while in its present tumbled and dispersed condition the width of the débris varied between 10 and 16 meters, the sections near stations 90 and 105 bearing evidence of having been especially massive. Near the slope to the east (stations 118 to 122) only very scanty remains of the wall are to be found. In addition to the stadia lines a few triangulation lines also were "shot," in order to locate some artificial lakes and a subterranean spring at the foot of the *kaleh* (Fig. 13). Of interest was the fact that on the Kiramitlik side the wall was for some distance discontinued (stations 35 to 38). At the same time we prepared also a small map (Fig. 3) showing the general situation of the city and its relation to surrounding tumuli and *hüyüks*.

Closer investigation of the outer wall, as partially preserved in some places, revealed that it was built upon a massive stone foundation some 5 or 6 meters thick at its top (see Fig. 12). To determine the original thickness at the base of the foundation would have required the removal of much fallen masonry, often consisting of very large stones. The angle of the outer slope of the foundations averaged about 60 degrees. Upon this foundation was built the city wall, which varied in thickness from 4 to 4.5 meters.

Protective towers had been built at irregular intervals, usually at points of obvious strategical or tactical advantage or near gates

(stations 59 and 89, and Figs. 7 and 8). I found only one tower whose walls were in the least preserved (station 52); all the others could be recognized only as great heaps of stones which had fallen outward from a structure of indeterminate height, the stones in some instances having tumbled to a distance of 17 meters from the actual tower wall. Apparently the towers were round or, at least, had rounded corners.

Of the large gates, only two are sufficiently preserved to enable us to discern something of their architecture (stations 1 and 84). In the case of the gate near station 84 the foundation walls of the two large, round-cornered gate towers are still visible (Fig. 7). On one occasion, in returning to our car we took another route and had to climb down over some 60 meters of refuse and rocks, the talus of the *kaleh* or castle itself. At several points we noticed that the slope of the elevation on which the *kaleh* was built had been paved with large stones (Fig. 11). Without excavation it is difficult to determine how far up into the talus the bed rock reaches.

The potsherds seen on the surface of the ruins are of a kind usually designated as "Hittite," with red or brown-red decoration on a grayish-white or buff-colored slip. Other sherds were simply plain buff and plain red ware. Interspersed among them were great numbers of Roman and even Byzantine glazed ware.

Importance of the Site

As to the origin and history of this city, or regarding its possible name and identity, I would not venture to hazard any premature statement at this time. I would only call attention to the fact that the character of its walls, the rounded corners in much of the construction, and the slope of the foundation walls, are reminiscent of the ruins at Akalan, near Samsun; while the general emplacement of the site reminds one of Boghaz Köi. In other respects, however, this city on the Kevkenes Dagh is not only very different from Boghaz Köi but encloses an area three times the size of the latter.

This city so spacious and so extensively fortified may well have been a long-forgotten rival of Boghaz Köi, lying behind the chain of mountains visible to the west; and it goes without saying that even the partial excavation of the place would yield splendid results. So large is the site that a campaign of less than seven or eight years would be of comparatively little use. Even a detailed survey of the surface remains would require at least six or seven months' work by a staff of experienced field workers.

THE GEOGRAPHICAL STUDY OF SETTLEMENTS

EXAMPLES FROM ITALY, GERMANY, DENMARK AND NORWAY

Hans Wilson Ahlmann

LEAVING the pleasant gardens and populous coasts of northern or eastern Sicily for the interior, a very different country is entered. For hours one can travel on the railroad without seeing men or their dwelling places. In winter the countryside is of a prevailingly brown or grayish tint, monotonous, desolate, bare: deforestation has created a steppe-like landscape. Here and there a stone hut hides its miserable poverty behind a clump of opuntias. A slit in the wall serves as a window; through the open door is seen a child with tethered goat. In the fields a solitary peasant guides a couple of oxen attached to a primitive plow. No other traces of human life in the fields. To discover such one must look up to the mountains and hilltops. Here the people live in towns, close-piled masses of gray stone houses.

Now turn to the country about Naples, the extraordinarily fertile Campania Felice. Here one can travel for mile on mile by a well developed system of tramways. Each town resembles the others so much that the map must be closely followed to know where one is. The towns are sharply divided from the fields but sometimes are so close together that you can call from one to the next, though because of the luxuriance of trees and vines no houses can be distinguished. The buildings front on the streets as solid blocks of masonry. Not until the courtyards are entered do you see that people dwell there and live by farming, or rather gardening. There are the stores from the harvest, there stand tools and wagons, donkeys, and in the better class establishments, cows; everywhere chickens and pigs and a hopeless jumble of people and rubbish. The town is purely rural in character, a big village.

Settlement Regions

Such are two types of South Italian communities. I shall have more to say of them later. Here I wish to emphasize the eloquence of such geographical facts, for they are the synthesis, the crystallization, of the civilization of the region, the complex of the natural and man-made phenomena of the land. It is the purpose of this paper to urge the study of settlements, as geographical entities. How are

human groups disposed over the earth, what are the distinctive characters of their establishments,[1] what their origin and evolution, are they comparable, can any principles of development be traced in the multiplicity of forms?

Of the factors that determine the character of human settlement the most important, in my opinion, is climate, and next come geologico-topographical conditions and the degree of material culture. Climate plays a decisive part by affecting the supply of water and the nature of the drainage system, by determining the nature of the vegetable world and the kind of the cultivated plants and, in consequence of this, the character of the agriculture; moreover, it exercises a great influence on the mental and physical vitality of the human inhabitants and has some effect also on the topography. Mr. Aurousseau discusses similar factors but with a different objective in his article on "The Arrangement of Rural Populations."[2]

On the basis of a synthesis of the conditions which these facts express the territories of the world can be classified into different settlement regions. It is scarcely possible at the present stage to make even a preliminary scheme for such a classification: it is a goal for future study. Among the territories which I shall discuss here Italy, or rather peninsular Italy and especially its southern districts, can be classed as belonging to the subtropical, dry-summer climatic region, where horticulture plays an important rôle; Germany and Denmark, to the humid-temperate, cold-winter climatic region, where agriculture has its highest expression, with intensive cattle breeding and dairying and, in Germany, universal industrialism; Norway, to the pine-forest section of the subarctic climatic region with stock raising and more or less scattered but well organized agriculture.

Settlement Series on a Topographical Basis

Within each climatologically determined settlement region are found areas of such varying topographic character that settlement presents marked differences of form, grouping, location, and development. In the course of its evolution it exhibits stages which bear a

[1] Vidal de la Blache and the French geographical school use the term "établissements humains." Aurousseau says "each natural region tends to develop a characteristic form of arrangement of its rural population" ("The Arrangement of Rural Populations," *Geogr. Rev.*, Vol. 10, 1920, pp. 223–240). Demangeon points out that the farmstead "est l'expression, modelée par les siècles, de la vie rurale" and "donne la solution d'un problème vital qui est de savoir comment s'établiront les rapports réciproques des hommes, des bêtes et des biens" (*Ann. de Géogr.*, Vol. 29, 1920, pp. 352–357).

[2] See footnote 1. After this paper had been sent in for publication, A. Demangeon's scholarly paper "La géographie de l'habitat rural" appeared in the *Annales de Géographie* for January and March, 1927. He discusses the reasons for compact and dispersed rural settlement. I have the pleasure of noting that many of the views which he takes as a basis for the geographical study of settlement agree with mine expressed here, especially as regards the necessity of study of historical development. In the application of these views we follow different paths; which does not, however, mean that our goal is not the same. See also the note "The Study of Rural Settlement," *Geogr. Rev.*, Vol. 16, 1926, p. 329.

definite relation to each other and which I have called settlement series (*Bebyggelseserien*). Tentatively I recognize the following:

1. General series in regions of normal fluvial erosion, with the exception of (2).
2. Mountain regions of young physiographic stage where a well defined horizontal zoning of climate and life obtains. A subdivision of this class includes glacially eroded mountains.
3. Coastal or littoral series.
4. Dry regions series.
5. Volcanic series.

The scheme here submitted rests on the conception of the whole process of settlement as a great unified complex; a living thing, constantly changing, advancing, retrogressing. However great may be the differences the settlement may show between the different series, however various may be the forms it assumes, it nevertheless seems to me certain that, on the whole, man takes possession of the country for settlement in a similar manner within regions where the dominating conditions in physical geography are similar and when men have there attained a similar degree of civilization. The scheme likewise is based on historical principles; for the present can only be understood by the past. I believe the basic idea is sound, and I hope from the analysis of individual regions to reach a final synthesis. O. Montelius instituted the excellent system of typological research in the realm of archeology. A similar method has its applications to the study of settlement.

The Subtropical Dry-Summer Region of Italy[3]

A typical subtropical dry-summer region is Sicily and the three southern provinces of the peninsula—Calabria, Basilicata, and Apulia. Marginal to it is Campania. The region includes a variety of topographic types; its unity lies in the summer drought which with high temperatures causes a shortage of water and in many cases makes irrigation a prerequisite to any intensive cultivation. Fall and winter rainfall are usually violent, and the dry watercourses of summer become raging torrents whose erosive power is heightened in many instances by the nature of the rocks and the deforestation, long in progress. Morphological changes are going on at an extraordinarily rapid rate. This is notable in the case of the so-called *fiumare*, ravining, to which is added the frequency of landslides and earthquakes, making unstable even the basis of settlement, the earth.

[3] Sicily, Calabria, Basilicata, and Apulia have been treated in more detail in my memoir entitled "Études de géographie humaine sur l'Italie subtropicale" (*Geogr. Annaler*, Vol. 7, 1925, pp. 257–322; Vol. 8, 1926, pp. 74–124, Stockholm). Reference may be made to that work for further information and for some account of the literature of the subject.

The olive and the vine, modest in water requirements, are characteristic. Most intensively exploited are the irrigated orchards of oranges and lemons. In Sicily and on the Calabrian coast sugar cane and cotton thrive, though neither is grown to any extent.

The region is particularly adapted for a study of the evolution of settlement because of the antiquity of its civilization and the vast literature available thereon. Progress of the general settlement series may be summed up in the following stages, beginning with the point when the population became sedentary by the introduction of agriculture:

1. Human establishments concentrated in agglomerations on the heights, the inhabitants being agriculturists.
2. Descent to the cultivated fields below the heights.
3. Dispersal of the population in the fields.
4. Development of towns, i. e. of a population not entirely dependent on agriculture.
5. Growth of the large cities drawing on a vast hinterland.

In subtropical Italy the series shows a characteristic ebb and flow, advance and retrogression; and some primitive features remain today. It shows concentration of dwellings in towns and villages, their hill-top location, and the large numbers of the population dependent on the soil for subsistence.

Historical Development of Sicilian Settlement

Going back to pre-Hellenic times we find settlements in Sicily on the tops of mountains and hills. Two well known towns, out of a long list of such settlements, are Eryx and Henna. The site of the former was the summit of Mt. Eryx, 751 meters high, in the west of the island. At the foot is the modern dispersed but dense settlement whose inhabitants still go up to the ancient site, now occupied by the village of S. Giuliano, for religious festivals. Henna, 997 meters high in the center of the island, is the modern Castrogiovanni. The ancient settlements formed islands overlooking the thickly wooded and ill-drained valleys; around were clearings of cultivated fields; their roads, *strade di spartiacque*, followed the ridges. In the southeastern limestone area of the island the most desirable locations were the bluffs of the deeply cut valleys or canyons.

We know little of the settlement of the interior during the golden age of Greece, for civilization was concentrated in the brilliant cities along the coast. Apparently there was some dissemination, but the population again took to the hills during the wars between the Greek cities and Carthage and the Punic wars. Under Roman rule the system of *latifundia* was introduced with extensive agriculture and

FIG. 1

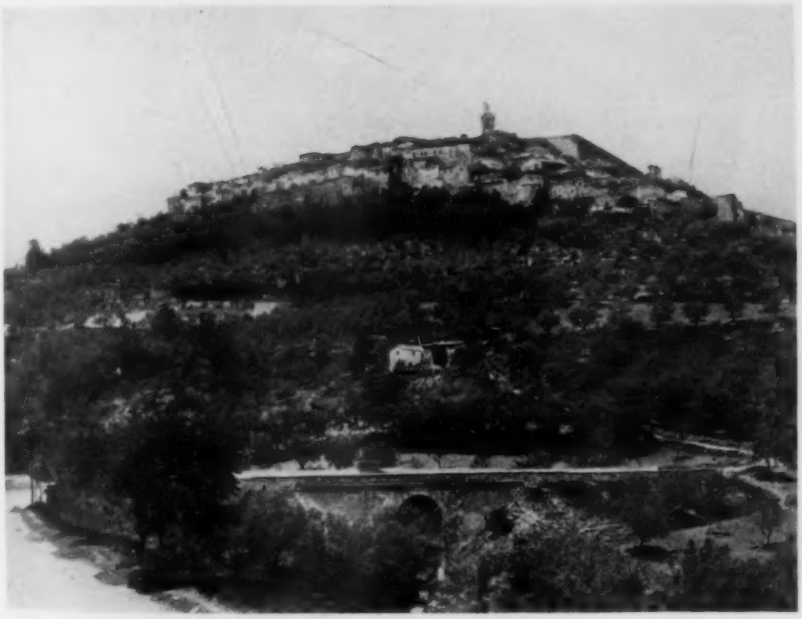

FIG. 2

FIG. 1—Calatafimi, a town of northwestern Sicily, 350 meters above sea level, on a rocky ridge 100–150 meters above the valley floor. Inhabitants in 1911 numbered 10,205. (Photograph by Brogi.)
FIG. 2—The town of Alatri, 60 kilometers east-southeast of Rome, 502 meters elevation, on the summit of a rocky hill planted with olive trees. Population in 1911, 4866. (Photograph by Alinari.)

concentrated settlement. Sicily became a wheat-producing land whose fields at Centuripa and Henna were of as much importance as the commerce of Syracuse.

The Arab conquest raised Sicily to a very high civilization. Irrigation and horticulture transformed the land. From the accounts of Edrisi and Ibn Jubeir we know that settlement took the form of scattered dwellings among the fields. Palermo, the chief city, bloomed in the middle of a huge garden. The total population is reckoned as 2,700,000. Under the later feudal system of the Normans civilization declined. Settlements were again concentrated, principally on the heights. The population of the sixteenth century is estimated at about one-third of that under the Arab régime. At the time of the Union of Italy Sicily found itself in a medieval stage of civilization.

FIG. 3—Castrogiovanni, the successor of the ancient town of Henna in central Sicily. Situated on a plateau-shaped rock, the surface of which rises about 500 meters above the floor of the valley, where the Catania-Palermo railway runs. Inhabitants in 1911, 24,600. Calascibetta, north of the railway, occupies a similar topographical situation, 878 meters above sea level, with 7663 inhabitants in 1911. (Published by special permission after the map, on the scale of 1:100,000, of the Istituto Geografico Militare of Florence.)

INTERIOR SICILY

As has been said, settlement today still retains certain primitive characteristics. This is especially so in the interior and on the south coast. Subtracting a zone 5 kilometers wide along the east, north, and west coasts, we have left an area of 21,287 square kilometers with a population of 2,078,025, or 98 per square kilometer—not a high density as things go. Of the population only 4 to 11 per cent (1911) live in scattered villages of less than 100 inhabitants. Considerable areas between Palermo and Sciacca, for instance, have no dispersed settlement. Towns with a population approaching 20,000 have a majority of their inhabitants engaged in agriculture. So also do towns surpassing 20,000, such as Piazza-Armerina, Girgenti, Canicatti,

Modica, Noto, Ragusa, Vittoria. Statistics show one-third engaged in agriculture; and, adding to that the large number who are described as "without profession," it is probable that two-thirds or more of the population are dependent on agriculture.

The accompanying graphs of hypsometric curve, number and density of population, show the tendency to location of settlements on the heights. Statistics, however, show an appreciable tendency of the population to descend to lower altitudes since 1861.

The house type is primitive. Characteristically it is a single-room square building, without chimney and with a door opening on the street. Excavations in the hillsides and caverns are still simpler abodes, and use of the latter was not infrequent at the beginning of this century. In 1901, for instance, in the town of Modica 938 caves were occupied as human dwellings. Now they are evacuated. Human establishments in the interior of Sicily and the life of the population taken as a whole give a striking picture of a primitive stage in our settlement series. The extreme development of *latifundia*, the curse of malaria, which in the lowlands has declined perceptibly only in the last decade, and brigandage are contributing causes. But one must not overlook the fact that the rough configuration renders difficult the supply of water for the irrigation needed by intensive exploitation. *Latifundia* occupy about 30 per cent of the whole island, the figure rising in an interior province, Caltanissetta, to 44 per cent. One-third of the area covered by cadastral survey is in the hands of 787 persons; one-sixth in the hands of 173 persons.

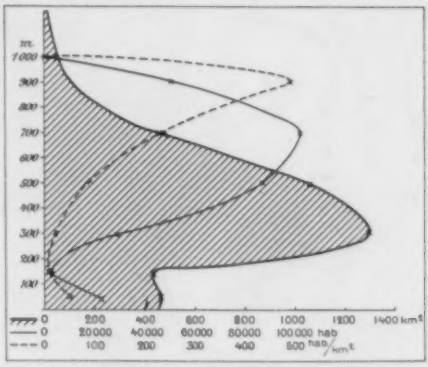

FIG. 4—Diagram of settlement of the Monte Erei district of southeastern Sicily, stretching from Terra Nova to include part of the Catanian plain. Shading shows the land area; the solid line, the number of inhabitants; the broken line, the density of population—all referred to heights above sea level. Among the towns in the district is Castrogiovanni (Fig. 3).

COAST SETTLEMENTS

The progress of settlement along the littoral is distinct from that of the interior. The series shows:

1. Small agglomerations in places with shelter for small vessels.
2. Concentration in places with good connections both with the immediate hinterland and over the water.
3. The great city with extensive commercial connections.

The Phoenicians or Carthaginians who first came to the shores of Sicily as colonists took possession of the capes and points, islands and peninsulas which offered protection from the wind. There they founded their trading posts. When the Greeks followed with greater intellectual and cultural resources they made use of the best harbors, creating important cities. Syracuse, for instance, was in its day one of the greatest world cities. The unique position of Sicily in the Mediterranean between east and west and as a bridge from the Apennine peninsula to Africa was now evidenced. The Greek cities had resources for their development quite different from those of the inland towns bound to their surrounding fields. During the Roman occupation the coast cities declined, to be revived by the Arabs. Relations with the north coast of Africa especially stimulated the southern cities. When it succumbed they also were lost.

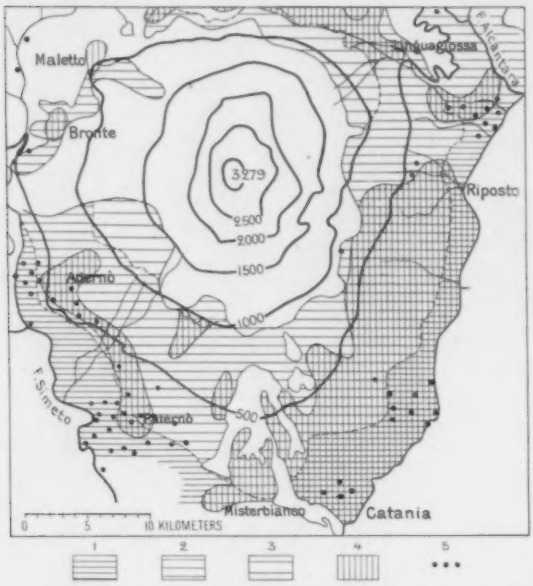

FIG. 5—Etna, cultivation and settlement map. Scale approximately, 1:6,000,000. 1, intensive horticulture, chiefly oranges and lemons, bounded by the upper limit of the olive; 2, less intensive cultivation, bounded by the upper limit of the vine; 3, more extensive cereal cultivation, bounded by the upper limit of rye; 4, thickly inhabited areas; 5, springs. Altitude curves, heavy solid lines, are drawn at intervals of 500 meters. Cultivated areas are after Paul Hupfer: Die Regionen am Ätna, *Wissenschaftliche Veröffentlichungen des Vereins für Erdkunde zu Leipsig*, Vol. 2, 1895, pp. 299–362. Springs are after the Carta idrografica d'Italia.

Unfavorable topography aided by sirocco and malaria still retards settlement on the south coast. The other three coasts show a higher stage of settlement than the interior. With an area of 2978 square kilometers they have (1911) a population of 1,094,200, or a density of about 365 per square kilometer. The dispersed population has a density of 50 to 100 per square kilometer against about 10 in the interior. The houses are better, urban development has been carried higher. The introduction of the orange was a specifically important fact for the coast zone; so later was the introduction of steamship lines for the export of fresh fruits. This type of fruit growing calls for intensive cultivation of the soil with irrigation. The greater part of the irrigated land in the island is in the coast zone.

Volcanic Settlement; Etna

Etna, a young volcanic mountain, offers special conditions for human occupation. Settlement is determined by altitude above the sea, by the weathering of the lava, access to springs, and exposure. The uppermost zone below the crater is occupied only by the temporary settlement of herders; settlement becomes denser with increased weathering and number of springs. The lower southeastern slope is the most densely populated district of Sicily. Leaving out the population of Catania, which is largely urban, the density of the rural population here is 430 per square kilometer. This high figure is permitted by the fertility of the soil and the climate, which not only favors horticulture and aboriculture but lowers the cost of living; though the standard, it must be noted, is very low.

Fig. 6—Distribution of population in Calabria, Basilicata, and Apulia. 1, uninhabited or very sparsely populated; 2, comparatively sparsely populated; 3, densely populated. Scale 1:4,200,000.

Settlement in Calabria

The distribution of population in the three southernmost provinces of Italy is shown in Figure 6. The areas of least density, less than 30 per square kilometer, are at the highest altitudes where rigors of climate discourage settlement, as in the crystalline massifs of Aspromonte, Silas, and the Serra S. Bruno of Calabria; or where extreme dissection of the surface gives an unfavorable topography, as in the "badlands" of the flysch of Basilicata or in the low river bottoms and the insalubrious coasts. High densities, over 100, are found in intermediate zones where intensive fruit and tree culture obtains, as well as in the northeast of Apulia, including Bari, and in Otranto.

From Scano's statistical reports[4] we learn that an increase of population in the lower zones of Calabria has been going on at the expense of the upper zones, a movement increased in late years by the coming of the railroad along the coast. The chief obstacles are malaria and in the valleys flood and erosion. As an illustration of settlement in Calabria we shall take the Crati valley. It is stated that Cosenza (ancient Consentia) was the site of the capital of the autochtonous Bruttiens. At the mouth of the valley was the famous Greek colony of Sybaris, and the great Roman road, the Via Popilia, passed by the valley.

Figure 6 shows how the population avoids the lower zone of the valley, where only a few scattered dwellings are to be found. On the western slopes the majority of the population lives in agglomerations in the upper zone at the contact between the unconsolidated sedimentaries and the schistose scarps where the oak forests cease and cultivation begins. The highest density is in the amphitheater about Cosenza, where it reaches about 200 per square kilometer excluding the big town. To the southwest on the schists, where springs occur, the population is more dispersed. Earthquakes are frequent, malaria is a serious handicap, and emigration is considerable.

Basilicata

The discomforts from which Calabria suffers are even more accentuated in Basilicata. Figure 7 of that part of Basilicata fronting on the Gulf of Taranto shows the lack of habitations on the sandy coast and the low coastal plain, fertile but devastated by malaria, and in the broad valleys whose swampy bottoms are choked by débris from the enormous erosion and the frequency of landslides to which the flysch, covering a large part of the region, is especially liable. The forests, the former wealth of the country, are in large part in bad condition. The density of the agricultural population is only 40–50 per square kilometer, and there is a continual drain from emigration. Only 7 per cent of the population lives in dispersed settlements. The largest agglomeration, Matera, has 17,324 people, the smallest 746.

Settlements seek especially the patches of hard rock, *rocco tetto*, outcrops of schist in the soft Eocene clays. Almagià indicates respective densities of 167 and 7 per square kilometer on these two formations in the Basento region. The patchy distribution means a condition of great isolation. Different settlement districts have different manners, for instance. The wretched roads run along the crests separating the valleys. Though the topography is mature, the valleys as barriers are comparable with mountain chains.

[4] Giulio Scano: Distribuzione, aumento e densità della popolazione italiana in rapporto all' altimetria dei centri abitati, *Riv. Geogr. Italiana*, Vol. 30, 1923, pp. 50–56, 158–168; Vol. 31, 1924, pp. 159–175.

Unlike the case in Calabria the railroad has not provoked settlement in the coastal lowlands of Basilicata: the railway stations remain isolated buildings in the deserted plain. The contrast with the

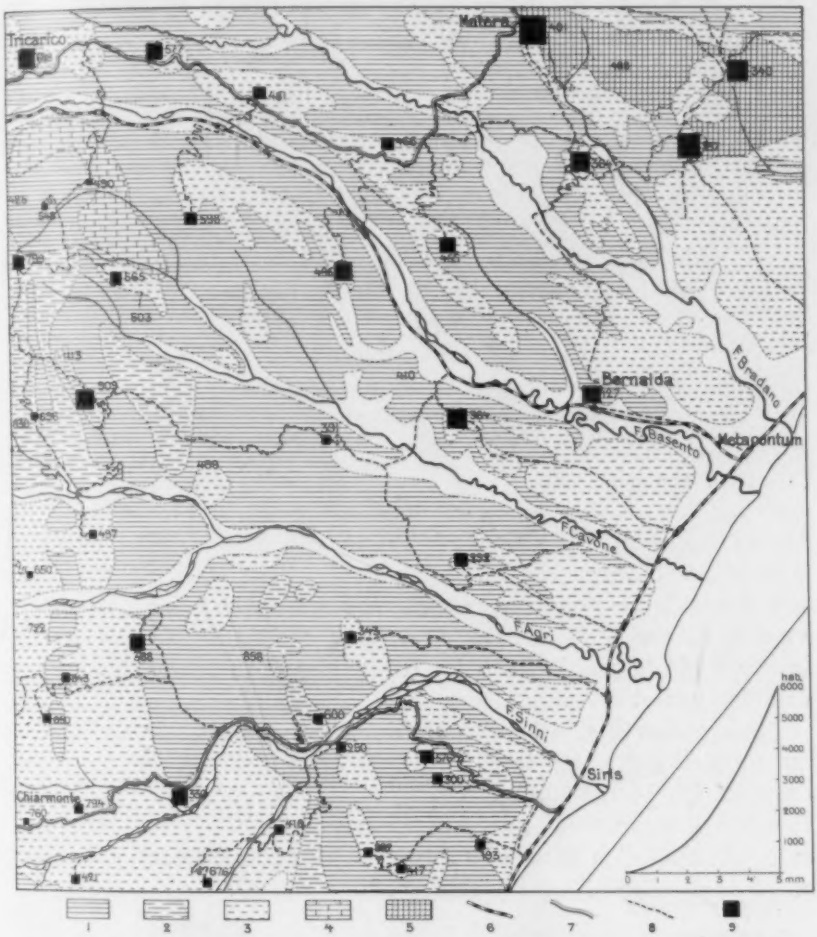

FIG. 7—The southeastern and central part of the province of Basilicata. Scale approximately 1:550-000. 1, impermeable clay, especially flysch; 2, compact sand and conglomerate, somewhat impermeable; 3, sand and gravel, not very permeable; 4, permeable lime and marl; 5, highly permeable compact limestone; 6, railway; 7, highroad; 8, secondary road; 9, agglomeration: population proportionate to the size of the square according to the scale in the lower right-hand corner of the map. Figures give heights in meters above sea level. In 1921 the population of the district was 163,400 persons. Of these about 92 per cent lived in the chief center of their respective communes. The number of agglomerations is 38.

ancient Greek coastal cities, such as Metapontum, is striking. That high stage of settlement, the highest for the region, was, however, an exotic flowering; without roots in native soil it bloomed and quickly died away. The present settlements belong to the first stage in the general series.

Apulia

In Apulia the chief Greek and Roman settlements are still represented by living Italian towns, the latter because of their strategic locations, the former because of their sites as good natural ports. This is in contrast to Basilicata, where the flourishing Greek civilization entirely disappeared. During the Middle Ages Apulia played an important commercial rôle in relation to the eastern Mediterranean. However, the coast settlement of today cannot be considered to have reached an advanced stage in the settlement series. The Emperor Frederick II built strong castles and fortifications on the heights, which still remain as the "altstädte" of many towns of today.

In addition to the reasons already cited for hilltop concentration in subtropical Italy it must be noted that a large part of Apulia, the limestone plateau known as the Murgia, is the driest part of southern Italy. Settlement is extremely concentrated in large cities, which lie spider-like in well developed nets of roads. *Latifundia* occupy a great part of the country. Omitting the Bari region, the dispersed population is only 5 per cent of the whole. During the last decade the district of Foggia, for example, increased by 13,382 persons; but the town of Foggia itself gained 13,625; i. e. the population of the country has declined in favor of the town. In connection with the water problem we may note the building of an aqueduct, the Acquedotte Pugliese, not quite completed, which exceeds in magnitude the great Roman aqueducts and is indeed the longest in the world (2650 kilometers). It supplies 268 agglomerations with drinking water.

This concentration is not only due to dryness but to the limited amounts of cultivable land. In the fertile Bari region there is a comparatively large number of small farms, and the dispersed population is 2½ times that of the other parts of the territory. The agricultural population has a high density, over 200 per square kilometer, and is increasing with the parceling of the ground.

The Plains of Campania

Of the parts of the Apennine peninsula destined by nature to become population centers the plain of Campania is preëminent. It is unusually advantageously placed. The plain, largely formed of the fertile volcanic tufa, is surrounded by fault scarps and volcanoes and opens theaterwise to the sea. In the plain itself the chief river, the Volturno, with its low swampy banks, offers no inducement to settlement but rather the reverse. It divides the plain in two parts; and the more important southern section is again divided by the Regi Lagni.

The settlement of the littoral series early reached a high development. In the lee of an isolated trachyte rock east of the Phlegrean fields the Greeks founded Kyme in the eighth century before our era, later the starting point for Greek colonization around the Gulf of Naples. Littoral settlement reached its peak during the Roman Empire with Puteoli and Naples, the naval base Portus Misenus, and the resort Baiae. In the interior, Capua was founded early. Its location, low on the plain, was something very rare in the Italian

FIG. 8

FIG. 9

FIG. 8—Isolated farm in the Bari district. The house is a simple parallelepiped with white walls, a small number of windows, and flat roof. Limestone fragments gathered from the plowed land have been piled up to form a wall around it. Olive trees behind the house; on the wall in front the single grapevine.

FIG. 9—Tuscan peasant farmhouse.

peninsula. Only the wealth of Campania permitted the city to survive various vicissitudes.

The extent of the peopling of the plain in antiquity is uncertain. The point to be emphasized is the hostility of the watercourses to settlement.

PRESENT SETTLEMENT ON THE PLAIN

The climate borders on the subtropical, and summer rainfall is still insignificant. The intensity of the garden cultivation and the huge harvests derived therefrom are well known. Under the grapevines which hang in garlands, like heavy draperies between the tall trees, grow corn and all vegetables. The verdure is an expression of fertility quite overwhelming to a northerner. This apparently inexhaustible bounty of thousands of years is the prime reason why the Campania is the most densely populated agricultural region in Europe. Settlement is extremely concentrated. Between towns one finds only an occasional isolated house and here and there a single large conical hut of poles, twigs, and straw.

As is seen from the map, settlement is divided into two regions separated by the area of less dense population around Regi Lagni.

The total population of the towns of the southern part was 266,000 in 1911. The largest town, Aversa, has 22,545; the smallest independent town, Casaluce, has 1399. A considerable proportion of the population outside of the independent towns live in smaller agglomerations very like them in character. The northern region had 111,000 people in the towns in 1911; Caserta, the largest town, had 19,808; and the smallest, S. Marco Evangelista, 1547.

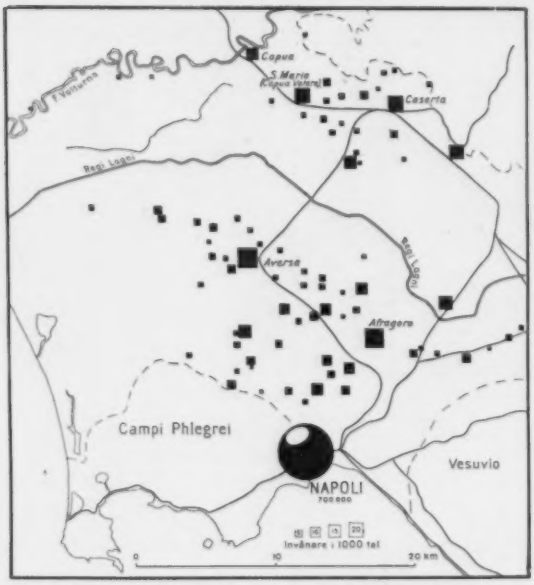

FIG. 10—Settlement on the Campanian plain between Naples and Capua. The population of the agglomerations (1911) is proportionate to the size of the squares according to the scale shown.

I lack material for exact computation of the density of the agricultural population. In the following I have estimated 80 or 90 per cent of the total population as dependent on agriculture, a figure probably not too high. Evidently such large towns as Aversa cannot live on agricultural enterprise conducted only within the limits of the commune. This is more nearly possible for such places as Melito di Napoli, Parete, Trentola, Lusciano, Frattaminore, and Crispano. The average density for these is 640 (80 per cent) or 725 (90 per cent). For the southern region as a whole I estimate densities of 756 or 850: for the northern region, 790 and 895. The highest figures are probably too high, but it can be safely said that the present density of population on the densely settled regions of the Campania plain is between 700 and 800 per square kilometer. Not only the fertility of the soil and the climate are responsible: the standard of living of the population is extremely low. The region is admittedly overpopulated; the highest density compatible with the good of the population is far exceeded.

Comparisons of Population Density in Subtropical Italy

The density of population dependent on agriculture for the regions of subtropical Italy studied is summarized thus: Basilicata, about 40; interior Sicily, 90; Bari district, 215–240; Crati valley, 200; southeastern Etna, 430; Campania plain, 700–800 per square kilometer.

Intermediate degrees are found; but 40–90, 200–240, 700–800 are indicative of the various stages of agriculture and stages in the settlement series within the region studied. It may be worth while to note that the lowest density here indicated is only a little lower than the highest density of Scandinavia. Density is a function not only of fertility but also of climatic influence on dwellings, clothing, food, etc., and of standards of living, all of which are relatively much higher in Scandinavia.

The development of settlement in the general series in southern Italy and especially Sicily in the course of history shows how, in periods with high civilization and peaceful conditions and good government, human settlement exhibits a tendency to break away from the agglomerations situated on heights and hills which form the primitive stage and to spread over the lower-lying districts. During periods of public and private wars, of lower civilization, and of inferior government human settlement exhibits a tendency to return to the primitive state. We shall now proceed to see how these stages in the general series are repeated in other parts of Italy and how their regular succession contributes to make clearer the causes why the city of Rome so early attained greatness.

FIG. 11—The city of Aversa, 14 kilometers north-northwest of Naples, in the southern part of the Campanian plain. Scale 1:25,000. Population in 1911, 22,545. (Published by special permission after the original map, on the scale of 1:25,000, of the Istituto Geografico Militare of Florence.)

THE RISE OF ROME AND HER GREATNESS[5]

Alba Longa, in the Alban mountains, was the progenitor of Rome. Historical records likewise show the mountains and hills around the Roman Campagna settled very early by the important cities of Tibur (Tivoli), Praeneste (Palestrina), Tusculum, Aricia, etc., the Etruscan cities of Caere, Veii, etc. From these descent was made for the pasturing of the flocks and herds. Movement down to the plain was given direction and made easier by the many small streams occupying ravines in the easily eroded soil and affording excellent

[5] See my study "Rom-Capua" (*Ymer*, Vol. 45, 1925, pp. 440–456) for greater detail and bibliographical references.

strongholds. In time the herds became permanently established on the plain, and the small groups of huts grew to towns. Their appearance and character are established by archeological finds.

A chief geographical reason for Rome's early greatness I believe to lie in her relation to the series of developments described in the foregoing pages as the general series. Rome, owing to her central position on the plain, surrounded by older centers of settlement on the circumjacent hills, was the first to draw advantage from the great material benefit which consists in the attainment by settlement of its second phase of development, namely the conquest of the low country. In other words, Rome reaped the benefit of the important process of development which consists in the moving down of human settlements from the heights to the lowlands. It was not alone her own strength nor her commercially strategic position on the Tiber, but it was all the power which had been accumulated in the mountain towns and for the first time was called forth, in the settlement and cultivation of Campagna, and which, so to speak, radiated topographically to the seven hills.

FIG. 12—Interior of a house in Afragola, 9 kilometers north-northeast of Naples, southern part of the Campanian plain.

DEVELOPMENT IN OTHER PARTS OF ITALY

During the long period of peace in Romanized Italy when no foreign armies trod the soil a considerable increase took place in the dispersed population on the lowlands. Growing prosperity and replacement of communal by private ownership created growing interest in agriculture. Especially after Sulla's dictatorship there began a feverish development which in the course of a century entirely revolutionized the old peasant civilization. Agriculture, which had been based on grain-growing, yielded to horticulture. Varro describes Italy as a kingdom of gardens. The more intensive cultivation demanded attention to irrigation. As now, it encouraged scattered settlements.

The tendency towards dispersion did not, however, reach its full development; nor did it last long. It constituted the best, the most powerful phase of the Roman state. The civilization which fostered the third stage of settlement was highly susceptible to changing influences since it depended so largely on careful drainage and irriga-

FIG. 13—Perugia. (From "Theatrum celebriorum urbium Italiae, aliarumque in insulis Maris Mediterranei," Joannes Jansonnius, Amsterdam, 1652?).

tion systems. The later swallowing up of the small holdings by the *latifundia*, the disappearance of the small peasant proprietor, and the resultant extensive culture, stock raising being most profitable, caused the collapse of the irrigation system. Grainfields became pasture, gardening declined, marshes crept in, and malaria spread. The population was again forced to the highlands to the old locations, and the second and third stages in the general settlement series became only a passing incident.

HILLTOP TOWNS IN ITALY OF TODAY

Not only in southern Italy is population today concentrated on the heights in agglomerations largely made up of agricultural workers. Every traveler in Italy is familiar with these towns on the hilltops, terraces, and highlands (Fig. 2). All the small towns are much alike

with their small gray stone houses fronting the steep crooked streets along which the peasants go to their fields in the morning and return in the evening.

Admirable as far as strategic location goes were the Etruscan towns. Many of their successors, Perugia, Orvieto, Volterra, occupy the crests of hills; Orvieto on its tufa cliff possesses such an extraordinarily fine location that it needed only a little construction to be practically impregnable to older military skill. Perugia spreads out on the broad ridges and corresponds in position with Siena. All the towns of today have their railroad stations at the foot of the hill.

In the Adriatic sub-Apennines settlement is confined to the highlands between the broad valleys with their overflowing rivers. The roads are typical watershed roads, *strade di spartiacque*. The region reminds one of Basilicata except that the population is much denser, averaging 100 per square kilometer; and the railroad along the Adriatic has stimulated a row of towns. As in Calabria this settlement, however, has been to a great extent independent of the sea.

In that part of Monferrat which lies between Asti Chivasso and Casale (east of Turin) the settlement is one of the most extreme highland type I have observed in Italy. The limestone mountain sides are given over to vineyards; the valleys are cultivated but are empty of habitation save for an occasional hut. The population is concentrated in fairly numerous towns on the ridge tops—generally a single or double row of houses strung along the road.

Along with this first stage settlement appears in some districts here a more dispersed settlement on the lowlands, representative of the second and third stages. The district of Florence and the Roman Campagna are cases in point.[6]

Numerous too are the towns in the mountains of central Italy which are now in process of abandonment, because their population is moving down to lower parts of the district. The development of human settlement is making rapid progress in the Italy of the present day; and here, as in so many other places, may now be applied the proverb cited by Vidal de la Blache from the Pyrenees, "baixar sempre, mouton no," that is to say, "always move downwards, never up again."

The Development of Towns in Germany

In passing from Italy to countries north of the Alps, it is necessary to touch, at least lightly, on the still discussed and far from solved problem of the rise of cities in Central Europe. In Germany, as in the rest of the Teutonic world in general, there is quite another difference and contrast between urban and rural settlement than that which prevails in Italy. Without exaggeration it may be said that

[6] See the note on Ashby's "The Roman Campagna in Classical Times" in this number of the *Geogr. Rev.*

no period of equal significance as that during which the towns came into being has been known in the history of settlement in Germany until the introduction of industrialism in our own times and the development of the modern great cities.

The First Sedentary Settlement

To the earliest permanent settlement the forest was an enemy in a very high degree. Hence the most suitable regions for settlement, and indeed those which were actually first taken into possession, in Central Europe lay chiefly on the steppe, where it borders on the forest.[7] The archeological excavations of later years in Germany indicate that sedentary settlement even in the Neolithic Age was gathered into groups rather than scattered. And such, indeed, it probably remained for a long period. In comparison with Italy, however, it must have struck observers as very primitive; and its lack of real towns led Tacitus and Caesar to describe it as scattered.

In those parts of modern Germany within the limits of the Roman Empire the Romans founded the first towns, some of which grew to be important, as Trier. With the decline of the Western Roman Empire came the decline of the Roman towns in Germany as in Italy. Sombart[8] is of the opinion that in Germany they entirely disappeared. In opposition Dopsch[9] maintains that Roman traditions persisted and that the towns though they lost in population and prosperity yet remained a foundation for later city growth.

As the Franconian Kingdom developed and Christianity was introduced agriculture also developed and land was inproved, so that about the eleventh century the landscape was differentiated into forest land and settled land, divisions which still persist in the main. The breaking up of the Carolingian Kingdom by the resulting lack of political and social unity delayed the development of settlement. Progress was chiefly accomplished by the large estates, especially those of the Church. The work of the Cistercian Order of Benedictines in regard to agriculture is especially worthy of note.[10] Reclamation of new land continued when the farmers were allowed to improve the common land of the village. Thereafter in the twelfth century agriculture became intensified. The advantages of multiple plowing, manuring, terracing of vineyards, and growing of forage plants began to be appreciated. At the same time vine and olive culture was revived in Italy, and in England new land was reclaimed and

[7] Robert Gradmann: Über die Bedeutung postglaziale Klimaänderungen für die Siedelungsgeographie, *Zeitschr. Deutsch. Geol. Gesell.*, Vol. 62, 1910, pp. 117–122. See, too, Hoops: Waldbäume und Kulturpflanzen.

[8] Werner Sombart: Der moderne Kapitalismus, 4 vols., Leipzig, 1919; reference in Vol. 1.

[9] Alfons Dopsch: Wirtschaftliche und soziale Grundlagen der europäischen Kulturentwicklung aus der Zeit von Cäsar bis auf Karl den Grossen, 2 vols., Vienna, 1918–20.

[10] T. von der Goltz: Geschichte der deutschen Landtwirtschaft, Stuttgart, 1902.

the three-crop rotation system introduced. Increased diking made possible the improvement of swampy lands.

The household economy of the past changed to a more highly developed money economy. Trade and communications increased. In the eleventh and twelfth centuries Germany added about 150 new towns:[11] in the thirteenth century at least 800 were founded. Kurt Hassert[12] says that in 400 years 2500 towns appeared.

Many other factors contributed to bring about this rapid development of the towns as a new form of settlement. The Crusades played a part because they acquainted other countries with conditions round the Mediterranean where towns were primary forms of settlement. Many old marketing centers naturally grew into larger places and became towns.[13] Villages also would seem to have been able to follow the same course of development. An important place amongst the towns of Germany is also taken by those which were founded within the area of German colonization in Slavonic territory.

The distinguishing feature between village and town is the presence in the latter of a greater number of food consumers who are not food producers. The creation of a town therefore implies a surplus of agricultural products. This medieval growth of towns exhibits very nicely the relationship between cultural-economic conditions and settlement, i. e. shows settlement as a result of the cultural level, which is one of the leading ideas of this paper.

According to the origin and functions of these medieval towns their present successors can be arranged in groups.[14] The distinctive differences appear especially in the network of streets, which is the conservative element in the structure of towns.

These medieval towns increasing rapidly in number and size are characteristic of a higher and later stage of development in the general settlement series. Culture, power, public interest located themselves there and the rural communities were left to live their own lives. Economic policy as a whole was very one-sidedly urban in character. A migration to the towns took place comparable with what took place in Italy in the Roman Empire and what is going on at an increasing rate in all civilized countries today.

Several scholars have emphasized the fact that the town walls which were built in the fourteenth century were as a rule satisfactory up to the mid-nineteenth century. Then urban population increased so much that the 500-year-old boundaries were transcended. It is of course true that the fourteenth-century walls in many cases included

[11] H. B. Knüll: Historische Geographie Deutschlands, Breslau, 1903, pp. 143–163.

[12] Kurt Hassert: Die Stadte: Aus Natur und Geisterwelt, Leipzig, 1907.

[13] On this so-called "Mark theory" see G. von Below: Zur Geschichte der deutschen Stadtverfassung, *Jahrbucher für Nationalökonomie und Statistik*, Vol. 105, 1915, pp. 651–662.

[14] Walter Geisler: Beiträge zur Stadtgeographie, *Zeitschr. Gesell. für Erdkunde zu* Berlin, 1920, pp. 274–296.

cultivated areas which could be used for building space, but on the other hand the medieval towns suffered from crowding, as we know by plans and house types.

Some Examples of Settlement in Denmark[15]

Denmark offers a fertile field for the study of settlement. Situated on the outer edge of the last ice sheet that covered the Scandinavian peninsula, this well defined glacial drift region has a marked topographic uniformity. The predominance of agriculture and the attention that has been paid in the country to the geography of civilization are other helpful factors in analysis of the problem.

The traveler passing from the rugged regions with their beech woods and coppices and isolated farmsteads to the open, gently rolling plain will see before him a picture of fertility and prosperity. Fine crops grow on the well-kept fields, well-fed cattle graze on the pasture lands, and numerous motor cars and bicycles roll along the excellent roads. Around most of the railway stations well-built little communities have sprung up. The small farmhouses with their four wings built in a square around an enclosed yard lie either scattered over the country or gathered together in small groups. These are the remains of the larger villages reduced by the agrarian redistribution of a hundred years ago. Both farmsteads and villages exhibit the solid work and the secure prosperity created by the rich soil and high cultivation of Denmark. Nearly everything looks different here from what we see in southern Italy; but nevertheless we shall find that in the main features of its development the settlement shows resemblances thereto.

The First Permanent Settlement

When agriculture and stock raising were introduced during the New Stone Age the people moved inland from their kitchen midden settlements on the coast and lake shores. Studies by S. Müller and V. La Cour[16] on the distribution of burial mounds from the Stone Age in areas in both northern and southern Jutland as well as in Zeeland show that early settlement avoided the lower lands of heavy clay soil, the steeper hills, the valleys, and the sandy heaths which last are even now largely uninhabited, choosing in preference the more gently sloping hills with light, easily cultivated soil. In a region studied south of Limfjord the burial mounds lie along well defined

[15] I have treated the settlement of Zeeland in an article in Swedish, "Själlands landsbygd" (*Ymer*, Vol. 43, 1923, pp. 81–126), and also have published a more comprehensive survey of the development of settlement in Denmark and Norway in an article "Om lagbundenhet i bebyggelsens utveckling i Italien, Danmark och Norge" (*Ymer*, Vol. 47, 1927, pp. 1–48, 139–172). These articles cite all the literature taken into account; with one or two exceptions the books and papers mentioned are published exclusively in one or other of the Scandinavian languages, Swedish, Danish, and Norwegian.

[16] Sjællands ældste Bygder. Copenhagen, 1927.

lines rightly interpreted as roads. These lead to the middle of the peninsula where, west of Viborg, was an important center. Many churches were later built along these Stone Age roads, and in many places modern highways follow them. The settlement sequence reminds us of Italy. The clay plains, difficult of drainage, more densely wooded, were more intractable to the cultivation of the time than the lighter sandy soils at higher altitudes.

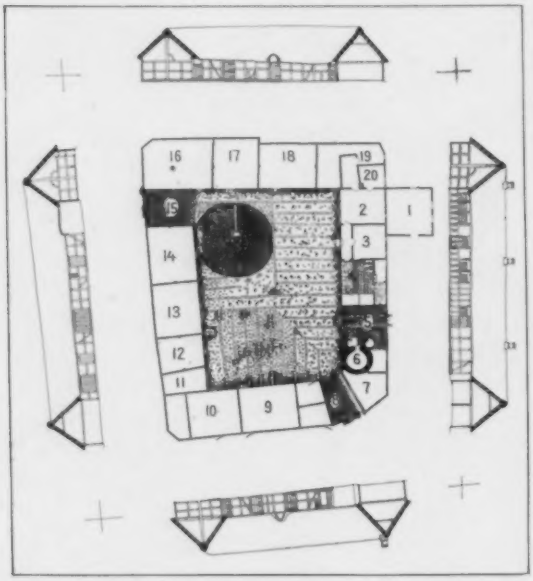

FIG. 14—Plan of a Danish quadrangular farm, Lundager, County of Odense, Fünen. 1 and 2, main rooms; 3, small room; 4, kitchen; 5, brewhouse; 6, bakery; 7, peat store; 8, gate; 9, stable; 10, cattle shed; 11, cart shed; 12, byre; 13 and 17, threshing floors; 14, rye granary; 15, main entrance; 16, barley granary; 18, granary; 19, chamber; 20, guest room. (After the original in the Danish Folk Museum, Copenhagen.)

During the Bronze Age settlement begins to move down to the lower clayey plain. During the Iron Age this movement continued. V. La Cour, in his recently published work, adduces weighty reasons for believing that fixed settlement even during the later Stone Age was concentrated in groups. Possibly it was only later, and in connection with the continued expansion of cultivated areas over the lower regions, that a scattered mode of settlement made its appearance.

VILLAGES AND DISPERSED FARMS IN DENMARK

It is still uncertain when the villages that were firmly organized on community of economic and social interests arose in Denmark. The villages appear in three forms, the closed or round village, with the farmsteads enclosing a square or circle about an open space; the long village, with farmsteads in two rows along a road; and the irregular village. In my treatise on Zeeland I showed how the villages are distributed in the open, gently rolling country, while dispersed farms on manorial estates and small hamlets are found in the wooded and more rugged country. In spite of the fact that there seems to be no difficulty from the standpoint of physical geography in changing the boundaries between these two regions, La Cour's work has confirmed my view that the great difference between them from the

standpoint of cultural geography has existed for a very long time, even from the New Stone Age.

Growth of Towns in Denmark

It is uncertain how and when the first towns in Denmark came into being. For the most part it was not until the remarkable growth

Fig. 15—Interior of the farmhouse at Lundager, County of Odense, Fünen. (After the original in the Danish Folk Museum, Cophengaen.)

of towns in Germany previously discussed spread to the southern Baltic regions in the late twelfth and early thirteenth centuries that Danish towns arose. These were usually founded at the command of a king or overlord for encouragement of trade and promotion of revenue. Suddenly, as if by magic, a host of towns sprang up in the thirteenth century, many along the coast. During the kitchen-midden period the coast, the strands of lakes, and watercourses had been the chief places of settlement; but with the coming of agriculture they had been more abandoned. Now the littoral series began to advance. At a very early time Hedeby-Schleswig was a considerable commercial center, and many of Denmark's most important towns, such as Ribe, Viborg, Aarhus, Randers, Horsens, Odense, Roskilde, were founded in the eleventh century. It is striking how many of these towns are situated at the farthest heads of the bays.

The towns founded by the Valdemar kings—twelfth to fourteenth

centuries—were usually built around church and market place. We can safely say of most of the older towns of Denmark that the size attained at the year 1500 did not appreciably change during the next two or three centuries.

Modern Settlement in Rural Districts

The settlement defined by the rise of towns and colonization of villages persisted until the agrarian redistribution beginning at the close of the eighteenth century. Then concentration in closed villages and the strip system of landownership were recognized as inefficient and incompatible with the rational use of land. The redistribution that followed was an unheard-of attack on a centuries-old tradition and carried with it revolutionary change in settlement of the rural districts.

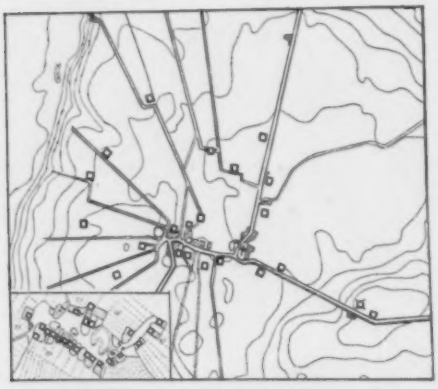

Fig. 16—Village of Faardrup, County of Sorö, Seeland. Scale approximately 1:35,000. The inset in the left-hand corner shows the village in 1770, before the rearrangement of holdings. The main map shows the present stage after this rearrangement, with the farms moved out to the edges of the hill on which the village stands.

Concerning relative populations it is to be noted that until 1877 the population of the rural areas was larger than the urban ones; but the situation has rapidly been reversed. Since the mid-century the railroads have been a deciding factor in the growth of urban and semi-urban population. Careful calculation of density of agricultural population per unit of cultivated land in eight chief farming areas of Zeeland shows that it varies between the close limits of 55 to 64 per square kilometer. An average of 60 per square kilometer of tilled land is therefore a measure of what the rural districts of Zeeland can support under existing economic and social conditions. This density has not changed from 1860. The best agricultural land of Zeeland is therefore saturated. The conditions are so stabilized that no change to speak of can take place except through some revolutionary occurrence.

The evolution of settlement which through the course of ages has led up to the present situation can be summarized in the following chronologically arranged stages:

1. Fixed dwellings gathered into groups and located mainly on the higher parts of the rolling plains of easily worked soil.
2. A movement down to the clayey areas, which is still going on.
3. The rise of the towns.

4. The government decree as to the breaking up of the enclosed villages by means of emigration to scattered dwellings.
5. The development of Copenhagen into a great city.

Copenhagen as a Metropolis

Figure 17 shows the territorial development of Copenhagan from the little shore village with a mooring place for vessels, which is

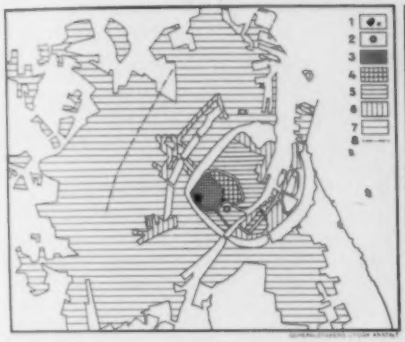

Fig. 17

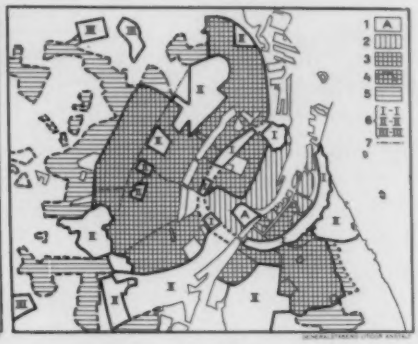

Fig. 18

Fig. 17—The evolution of Copenhagen proper. Scale approximately 1:180,000. 1, approximate site of first village and harbor; 2, Bishop Absalon's castle (1167); 3, the first town, probably as in Bishop Absalon's time; 4, urban area within the fortifications at the close of the thirteenth century; 5, urban area about 1700, within Christian IV's fortifications in the seventeenth century; 6, urban area about 1854; 7, urban area of Copenhagen proper about 1921; 8, the boundary line in the year 1660. (Compiled from D. Bruun; Danmark, Vol. 2, Copenhagen, 1919, and from maps of Copenhagen and its environs in the Uppsala University library, especially T. Brandh's map of 1854).

Fig. 18—Map of Copenhagen proper. Scale approximately 1:180,000. 1, Slottsholmen ("The Castle Island"), population density 1100 per square kilometer; 2, "city" area, density 24,900 per square kilometer, with the naval and commercial harbor on the east; 3, area of close settlement, density 40,000–82,000 per square kilometer; 4, part of Frederiksberg, within 3, that has density of only 25,000 per square kilometer; 5, area now being built up, density varying about 25,000 per square kilometer; 6, three open belts of parks, hospitals, cemeteries, station yards, aerodromes, etc. (Based on the map on the scale of 1:20,000 which accompanies "Statistisk Aarbog for København, 1924," and the population statistics in that annual.)

mentioned in history for the first time in 1043, down to 1921, when the urban area included in the map contained 700,610 inhabitants. This development has been greatly affected by the fortifications around the town. The older girdle of fortifications from the close of the thirteenth century was replaced in the middle of the seventeenth century by a large new girdle. The increased population of about 45,000 souls between 1801 and 1852 found accommodation within the walls by increasing the heights of the houses from 18 to 21 ells. Pressure of increasing population continued, however; and in the mid-nineteenth century the fortifications were razed, and the ramparts and moats were partly transformed into parks.

Figure 18 shows the morphological divisions of the city of Copenhagen as it finds expression in different degrees of density of popula-

tion. The accordance between this map and the preceding one is manifest. Slottsholmen, where Bishop Absalon's stronghold was situated, is still occupied by a palace (now the Houses of Parliament) and other large public buildings, which causes the density to be the lowest. Adjacent parts of the oldest and the older parts of the town now stand out as a "city" core. The density of population in this core was 51,000 per square kilometer in 1880 and has since then fallen continuously, being 37,700 in 1901, and 24,900 in 1924. In the great residential area the density varies between 44,000 and 82,000 per square kilometer, according to the height of the houses and the size of the dwellings, a matter which in its turn is connected with the economic circumstances of the inhabitants. In one special area (in Fig. 18, No. 4, indicated by a dotted line) the density is only 25,000 per square kilometer, because it is composed for the most part of the one-family houses of the well-to-do class.

Every great period in the development of the town since its emancipation through the razing of the seventeenth century fortifications forms, as it were, a new zone, consisting of a more or less continuous area of settlement surrounded on the circumference by the space-exacting establishments with open spaces which the humanitarian and hygienic ideas of the time demand—parks, hospitals, almshouses, and other municipal institutions, and establishments such as gas works, cemeteries, and the like. Three concentric open zones now exist in the city.

Of no small interest for our conception of the character of the modern metropolis of Copenhagen is the make-up of its population with regard to origin. Of the 700,610 inhabitants of the town in 1921, 323,311 had immigrated there; and of these 152,829 (22 per cent) had been born in the Danish countryside, 108,574 (15 per cent) in the provincial towns, and 42,673 (6 per cent) abroad. According to the census of 1921 the number of inhabitants in the Danish countryside was 1,760,000 and in the Danish provincial towns 643,600 (if the districts in South Jutland obtained after the World War are deducted). Thus it is a great tribute which the country as a whole has paid to its capital.

Settlement in Norway

The interior of Norway presents a glacially eroded alpine region, with well marked mountain settlement series, while the fiord-broken coast with skerries shows a distinctive development of the littoral series.

In Norway the roads are long and steep, the fiords and valleys deep, and the population scanty; the settled districts are far apart and do not greatly change the face of nature. The small gray houses

FIG. 19—Steep upper end of Flamsdal towards the Hardangar fells. The bottom of the valley, at the foot of the serpentine road, lies about 450 meters above sea level. Here permanent agricultural settlement ends. At the extreme right, at the summit of the road, can be seen Myrdal station (867 meters above sea level) on the Bergen-Oslo railway; tunnels on both sides of it. To the left of the picture a tourist hotel. (Photograph by Wilse.)

of the fishing population cling limpet-like to the naked coast; the isolated farmsteads press close against the mountain sides, their *saeters* high up above them; the streets of the towns feel their way cautiously along the shores and over the rocky hillocks as they can.

FIG. 20

FIG. 21

FIG. 20—Balstad in Lofoten. A typical fishing station situated on the low coastal platform, from which the fells rise steeply to a height of 300–500 meters. The larger houses back from the shore belong to the settled population. On the shore itself warehouses and cottages for use during the cod-fishery, January–April. (Photograph by Wilse.)

FIG. 21—Bergen: the oldest part of the town at the end of the nineteenth century. Tyskebryggen (the German quay) in the middle, with long houses, gables facing the harbor. The wooden buildings on the quay have been replaced by stone and modern equipment. (Photograph by Selmer).

FIG. 22

FIG. 23

FIG. 22—Feigum on Lysterfjord, Sognefjord. The waterfall from the hanging valley drops about 480 meters into the glacially overdeepened fiord. In front of the fall a bit of open country covered with glacio-fluvial deposits, which supports a few farms.

FIG. 23—Moskenesö, Lofoten, at the lower end of Djupfjord, showing the extremely barren state of the country. In the foreground the modest home of a fisher family.

Early Settlement in the Interior and on the Coast

The districts which attracted the earliest agricultural settlers in Norway were the large low islands of Westland[17] and the country surrounding the fiords, open and readily accessible, and where the ground was easily worked, conditions filled in the inner parts of Eastland around the lower parts of the great valleys—Österdal, Gudbrandsdal, and Valdres. Then, as now, the Silurian districts possessed many advantages. Settlement seems to have been made mainly on the higher ground. During the Iron Age it became clearly concentrated on the mid-slopes of the valleys, sunny and well drained. Brögger and Shetelig[18] maintain that in Westland the population which had adopted permanent dwellings in consequence of the introduction of agriculture largely retained the old fishing and hunting grounds out on the coast. Serious occupation of the forest-clad interior did not begin until iron had placed in the hands of man an easier means of clearing the land. Here the process of colonization advanced mainly along the sides of the valleys and more particularly in their upper sunny parts. Towards the close of the Viking Age (eleventh century) the habitable parts of the country had for the most part been taken into possession, even though settlement within them was thin and scattered. In Eastland, according to M. Olsen[19], the larger number of the old settlements remained comparatively unchanged until the great development of the twelfth and thirteenth centuries brought about expansion in the forest, up the heights, and down the valley sides. Summer pastures also became permanent farms. Mountain pastures had early been occupied, especially in the great valleys of Eastland, where the precipitation is small (250–600 millimeters). Here, according to Brögger, the present zone of mountain pastures was in use as early as the sixth to eighth centuries of our era. Hunting also continued to play a great part. These two occupations involved seasonal migration on a large scale.

A large number of the old hunting centers along the coast were inhabited only during the season, but others with some cultivable soil acquired a sedentary population with fishery as the main source of livelihood. As certain kinds of fish, such as cod, appear in huge quantities at definite times and at places which have only very little cultivable soil and possess no possibility of providing for any appreciable settled population (e. g. the Lofoten Islands), there arose quite early an extensive seasonal migration amongst the coastal population.

[17] In the following pages the name "Westland" is used to denote the western part of Norway south of Trondhjem Fjord; "Eastland" to denote the eastern part of that area; "Northland" to denote the region between Trondhjem Fjord and latitude 70° N.; and "Finnmark" to denote the region northeast thereof as far as the Russian boundary.

[18] A. W. Brögger: Norwegische archæologie; and Haakon Shetelig: Archéologie norvégienne. Inst. for sammenlignende Kulturforskning, Oslo, 1925.

[19] M. Olsen: Ættegård og helligdom. Inst. for sammenlignede Kulturforskning, Oslo, 1926.

Owing to the extraordinary wealth of the Norwegian coast in skerries and fiords and to the fact that fish early became an article of international commerce, the towns of Norway mostly belong to the littoral series. Several such towns came into existence in the thirteenth century. According to Bull, the chief agent in their creation in Norway was the Church, especially in its capacity of founder and owner of great landed estates. It is highly probable that on

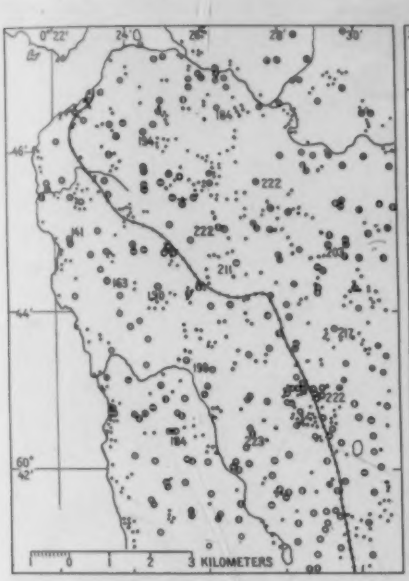

FIG. 24

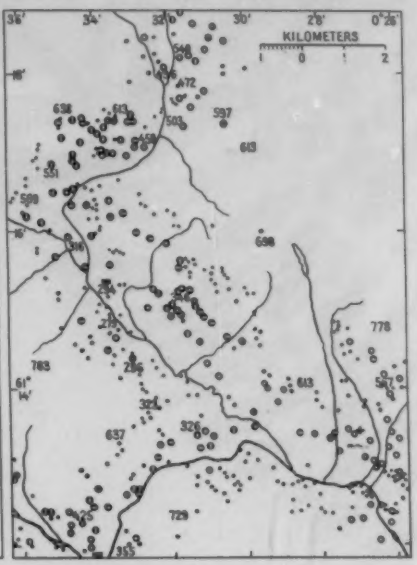

FIG. 25

FIG. 24—The district round Stange near Mjösen, 10 kilometers south of Hamar. Scale 1:170,000. The circles mark fairly large farms; the dots mark smaller farms and also dwelling houses of the non-agricultural population; the figures indicate meters above sea level. The markedly scattered nature of the settlement is the most distinctive feature of the district. (After the topographical map on the scale of 1:100,000, No. 26 A., Hamar.)

FIG. 25—Öst Gausdal, with adjacent districts, 25 kilometers northwest of Lillehammer. Scale, 1:170,000. The circles indicate fairly large farms, the dots mark smaller farms and also summer pasture dwellings and dwelling houses unconnected with agriculture; the figures indicate meters above sea level. (After the topographical map on the scale of 1:100,000, No. 31 B., Gausdal.)

these estates, as was also the case in Germany, the monks introduced a better and more rational system of farming. This was one of the most important economic prerequisites for the rise of a burgess class in the town in their capacity of consumers of the agricultural surplus.

The coastal towns of Norway were planned in relation to the water. In contrast to the towns of central Europe, they were not fortified until, in the sixteenth and seventeenth centuries, simple defenses in the form of wooden stockades were erected. Bergen, dominating practically the whole of the Atlantic coast of Norway and the Arctic coast as far as the Russian boundary, became the most important town in Norway and one of the most important members

of the German Hanseatic League. The settlement of Northland was thereby retarded.

The introduction of water-driven sawmills, probably at the beginning of the sixteenth century, initiated the first real economic gain since the early progress of fisheries and agriculture. Exploitation of the forests at first chiefly affected settlement on the southern

FIG. 26—Ål in Hallingdal. The old settlement situated on the valley side, the cultivated land lying in forest clearings. The sunny northern side of the valley is more cultivated and more abundantly peopled than the southern side. A small station community has sprung up around the railway station on the Oslo-Bergen railway. (Photograph by Wilse.)

and eastern coast, within which the great forest expanses lie. Here arose many small exporting and trading centers, which afterwards became concentrated into a smaller number of larger ones. Among these last Drammen is the most important. On the Atlantic coast fishery was improved during the latter half of the seventeenth century, partly through the invention of new implements and partly through the curing of cod as klipfish. In consequence rivals to Bergen sprang up in the form of new towns south of the Trondhjem Fjord.

LATER SETTLEMENT IN THE INTERIOR AND ON THE COAST

The increased value of the forests after the middle of the sixteenth century accelerated the downward movement of settlement. Farmsteads were chiefly isolated but in certain districts collected in

FIG. 27

FIG. 28

FIG. 27—A still-surviving *graend* at Voss between Hardanger and Sogne. (Photograph by S. Hasund, 1914.)

FIG. 28—Scattered farms after redistribution of holdings at Söndfjord in Westland. Each group of buildings indicates a farm except the second from the right, which comprises two farms. These latter mark the place of the old farm group of *graend*. The farms are all situated on the upper edge of the unconsolidated deposits, high above the still uninhabited floor of the valley. (Photograph by S. Hasund, 1913.)

small irregular groups known as "graender." The larger farms might consist of twenty to fifty separate buildings which lay quite open, often not even enclosed by a fence. The supply of building timber was practically unlimited, and also the space for building sites.

The introduction of more modern plows of an English type in the middle of the eighteenth century and the commencement of a rational system of highway construction towards the end of the same century proved two important factors of progress, especially in the more open Eastland. Here the use of mountain pasture diminished or was entirely abandoned. Small commercial agglomerations arose in the lower districts, a tendency which continued at a heightened pace when the industrial age, with a consequent increase of money economy, at length made its way into the country. The tradition of many centuries was broken, and the isolation of the various settled districts diminished; people continued to move down from the higher districts, badly situated with regard to communications, and to foregather more and more at the traffic centers; and manufacturing districts grew up, even though their number and size do not yet correspond to the immense resources of the country in water power.

An increased scattering of settlement concomitant with the downhill movement does not appear so distinctly here as in the countries previously examined, because the country was thinly peopled and settlement probably dispersed from the beginning. But a wider distribution of population was encouraged by greater liberty in the choice of dwelling places. As in Denmark, a rearrangement of holdings under pressure of the state broke up most of the old "graender."

The introduction of steam vessels had vast consequence for the coast. The hegemony of Bergen was broken down; and new towns arose, even in the backward parts of Northland and Finnmark. Settlement on the south coast was greatly affected by the establishment of the great steam sawmills, and that south of Bergen by the return of the herring to these waters in the middle of the nineteenth century. Several great manufacturing centers, deriving their energy from the waterfalls of the interior, were established on the seaboard. Where the littoral series meets the most richly developed settlement in the interior, at the head of the Oslo Fjord, Oslo rapidly grew into the largest town in the country with a population of 252,830 in 1925.

The Stages in the Settlement Series and Density of Population

It is probable that the stages in the settlement series of the different regions also follow a general law with regard to density of population in both rural and urban districts. In Zeeland for decades the density of the agricultural population has been about 60 per square kilometer;

and from the south of Italy I have given series of population densities that are characteristic of certain stages of development in the growth of settlement in that country. These stabilized conditions do not change until such inventions are made or such events occur as effect an entire transformation. In the subtropical region horticulture and irrigation have played that part. In Germany the growth of agriculture and the increased importance of a money economy during the Middle Ages, at least, very greatly promoted the rise of towns—a fact which is one of the most remarkable events in the history of settlement in the Teutonic countries. In Denmark the gradual improvement of agriculture led to the perfection of the village type of settlement, but later the redistribution of holdings had a revolutionary effect on that country. In Norway the preparation of dried fish and later of klipfish gave rise to the development of the towns of Westland.

Summary

In order to illustrate the point of view which I present for the geographical study of settlements, I have endeavored, as briefly as possible, to relate certain circumstances in the historical development of settlements and their state at the present time. The four territories discussed belong to three European regions, primarily defined climatologically. It is necessary to know something of the historical sequence of events in order to understand the present character of settlement. By means of it I have also tried to show that in topographically different districts of these regions settlement shows development in relation to the natural and social conditions in such a manner that one can speak of a regular settlement series evolving according to a definite law. At least this conception may be taken as a working hypothesis.

Within the subtropical settlement region, the history of settlement in Sicily illustrates particularly well the development of the general and littoral series, which is again well exhibited in its principal features in the other districts too. The Crati valley shows this, as well as Basilicata, in which the extremely unfavorable physical geographical conditions have retarded settlement in the first stage of the general series. In Apulia, the fruitful Bari district shows how settlement can progress to dispersion in connection with an increased and highly developed cultivation of the ground. Campania is an example of an exceptionally fruitful, overpopulated plain, where settlement is still strongly agglomerated, which adds to a large extent to the misery of the social and material conditions. The development of the general settlement series has been applied in regard to Rome as a significant explanation of the much discussed problem of the city's swift and powerful growth. In other parts of Italy the first stage still holds

over certain areas, but a downward move and dispersion of settlement is now making itself strongly felt.

The origin of the medieval towns of Germany, belonging to the humid, temperate region, characterized the development of the fourth stage of the general series and took place in connection with an important phase in the advancement of material culture there. In Denmark, belonging to the same region as Germany, the history of settlement shows features which remind one of those in Italy. The agrarian redistribution has been a powerful means of breaking up villages and extending settlement in order to obtain better results from the agricultural possibilities. In Norway, belonging to the subarctic region, the littoral series is the most important and has followed the same course of development as in Sicily. In the development of the mountain series a tendency to move downwards is found to recur many times. This series owes its character, for the rest, to the fact that settlements in all times have been chiefly scattered.

ON COTIDAL MAPS

H. A. Marmer

U. S. Coast and Geodetic Survey

ON maps delineating the features of the earth, the sea is generally pictured as a vast plain undistinguished by any marks of whatever kind. Even when contour lines or soundings are shown in ocean areas it is to the land that they refer—to the land beneath the sea. The surface of the sea, however, is not a monotonous plane stretching from horizon to horizon. For altogether apart from the swells and waves which are brought about in the surface layers of the water by the play of wind and weather, the sea sustains periodic changes in response to the mighty pulse of the tide-producing forces. Twice daily, in rhythmic fashion, the tide-producing forces of sun and moon stir the sea to its depths and give rise to the phenomena which for short are called the tide.

In so far as our knowledge of the tide is based on observed data, it may be said to be confined wholly to the coast line. The difficulties involved in measuring the rise and fall of the tide in the open sea are obvious, and as yet there are no such observations at hand. To be sure the mid-ocean islands interrupt, here and there, the wide expanse of tidally unknown seas; but these islands are few in number. Moreover, the tide rising and falling on the island shores is no longer the unaffected open ocean tide; for in breaking the uniformity of the ocean depths, the islands by the same token modify the tide.

It may perhaps not be out of place here to emphasize the fact that the tide has its birth in the open ocean basins. It is the action of the tide-producing forces of sun and moon on the waters of these huge basins that makes possible the rise and fall along the coast. What, geographically, is the course of the tide across the oceans? How can the progress of the tide from place to place be pictured? It is these questions that cotidal maps attempt to answer.

Cotidal Lines and Cotidal Hours

The term "cotidal" appears to have been coined by Sir John Lubbock in 1831. In his paper "On the Tides in the Port of London" he speaks of "*cotidal* lines," adding in parenthesis "I mean the series of points at which it is high water at the same instant."[1] A cotidal

[1] J. W. Lubbock: On the Tides in the Port of London, *Philos. Trans. Royal Soc. of London*, Vol. 121, 1831, pp. 379–415; reference on p. 382.

line is thus a line connecting points on the ocean at which high water occurs simultaneously.

To show the progress of the tide from place to place the cotidal lines must be numbered in some way. This means that some zero time of tide must be established. Since, as it is colloquially put, "the tide follows the moon" it is of advantage to take the time of the moon's passage across some meridian as the zero hour, and for this purpose the meridian of Greenwich naturally suggests itself.

Now the average period of the tide (the time interval from one high water to the succeeding high water, or from one low water to the next low water) is 12 hours and 25 minutes, or half a lunar day. Obviously, it will be of advantage to have this interval divided into equal parts, which solar hours will not do. But it may be done very conveniently by dividing it into 12 lunar hours, which means that each lunar hour is 1.035 solar hours. Cotidal maps, therefore, are generally drawn with cotidal lines numbered from 1 to 12 (12 being used in preference to 0), the time being lunar time referred to the moon's transit across the meridian of Greenwich as the zero hour.

It has been customary for many years to define the time of tide at a place by its relation to the time of the moon's local transit. For the high water this interval is known as the high water lunitidal interval and gives the hours and minutes (in solar time) by which, on the average, high water at that place follows the moon's local meridian passage. It is important to note that the times shown on cotidal maps are not the lunitidal intervals; and, to distinguish between the two, the time of high water at any place as determined in Greenwich lunar time is called the cotidal hour.

The relation subsisting between the lunitidal interval and the cotidal hour at any place can be readily determined so that they may be converted one into the other. Stated briefly, the high water lunitidal interval at any place may be reduced to the cotidal hour by dividing by 1.035 and adding one-fifteenth of the longitude if west, or subtracting if east. Thus Atlantic City, N. J., in longitude 74° 26′ W., has a high water lunitidal interval of 7 hours, 13 minutes. Its cotidal hour therefore is $(7.217/1.035) + (74.43/15) = 11.93$ hours. The advantage of using cotidal hours is that it makes the tide at all places directly comparable in time, which is not the case with lunitidal intervals.

Earliest Cotidal Map

Some twenty years before Lubbock's use of the term "cotidal lines" the idea of representing the progress of the tide by a system of lines was put forward by the English physicist, Dr. Thomas Young; and in his "Natural Philosophy," published in 1807, he illustrates

the progress of the tide around the British Isles by such a system of lines.[2] His map, reproduced in Figure 1, is the first cotidal map known, but it is clear that Young intended it more in the nature of an illustration than as a definite attempt to depict the precise course of the tide.

Lubbock's paper "On the Tides in the Port of London," to which reference has already been made, was illustrated with two maps, "the one showing the time of high water on the coast of Great Britain, the other throughout the world, or at least in as many places as it has been ascertained."[3] He makes no attempt to draw cotidal lines but contents himself with noting the cotidal hours at a number of places along the various coasts. With regard to these cotidal hours, however, he remarks, "It will be seen that the continents alter the direction of the cotidal lines . . . and that the progress of the tide is not always from east to west: in the Atlantic it is from south to north; so that it is high water at nearly the same time on the coast of Portugal and on the opposite coast of America."[4]

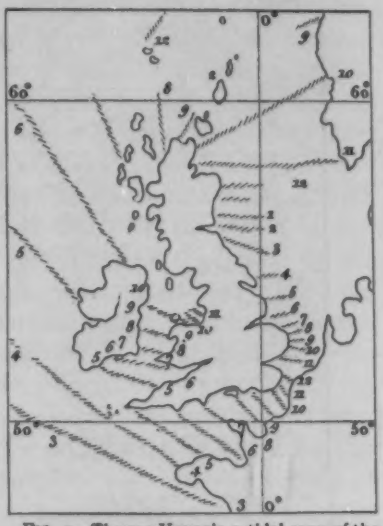

FIG. 1—Thomas Young's cotidal map of the British Isles, 1807. This is the earliest example of a cotidal map known.

In explanation of Lubbock's remark that "the progress of the tide is not always from east to west" it is to be observed that the notion of a westward movement of the tide across the seas was one of long years' standing. For it was argued that since the tide follows the moon, the progress of the tide must be from east to west; and therefore the tide was conceived as a wave moving westward following the moon.

It should be noted that Young in his cotidal map joined two points on opposite shores having the same cotidal hour by a straight line. In narrow seas this procedure appears reasonable as a first approximation. But, when it comes to ocean areas, such procedure is altogether too simple to fit the facts. In other words, across the open sea cotidal lines can be drawn only in accordance with certain assumptions as to the nature of wave movement, or in consonance with some theory of the tide.

[2] Thomas Young: A Course of Lectures on Natural Philosophy and the Mechanical Arts, 2 vols., London, 1807; reference in Vol. 1, p. 582.

[3] Lubbock, *loc. cit.*, p. 382.

[4] *Ibid.*, p. 382.

Whewell's Cotidal Map

The first comprehensive cotidal map of the world is due to William Whewell. In 1833 he presented before the Royal Society of London a paper entitled "Essay towards a First Approximation to a Map of Cotidal Lines."[5] Two cotidal maps accompany the paper, one for

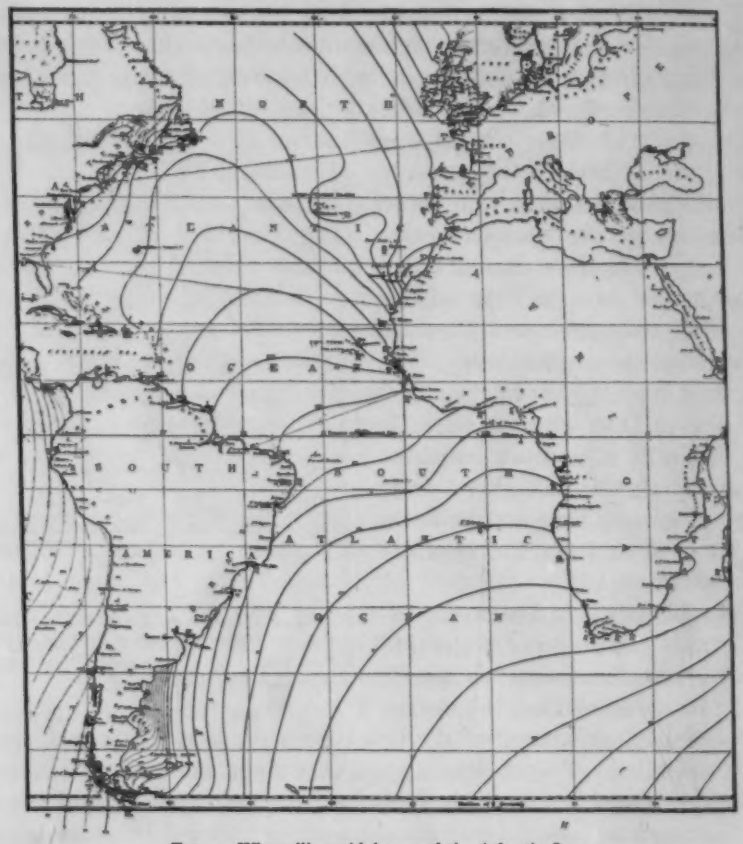

Fig. 2—Whewell's cotidal map of the Atlantic Ocean.

the British Isles and the other for the world at large between the latitudes 60° N. and 52° S. In the latter of these maps the cotidal lines are drawn across the wide expanses of the Atlantic and Indian Oceans from shore to shore; but in the Pacific Ocean the cotidal lines, because of the meager information at hand at that time, go out but a short distance from the western coast of the United States. Note may be made, however, of a number of cotidal lines across the Southern Pacific from Chile to the Friendly Islands. In Figure 2 the cotidal lines for the Atlantic Ocean are reproduced from Whewell's map.

[5] William Whewell: Essay towards a First Approximation to a Map of Cotidal Lines, *Philos. Trans. Royal Soc. of London*, Vol. 123, 1833, pp. 147–236.

As a preliminary to drawing his maps Whewell considers the form cotidal lines must have in virtue of the laws of fluid motion. He shows that they must be convex in the direction of wave progression, because the tide wave will progress faster in the deeper central part of a channel than in the shallower areas near the shores. He considers also the effects of islands and shoals, concluding that these must deflect the course of the cotidal lines in their vicinity.

Whewell expressly states that he endeavored "to trace the course of the cotidal lines according to which the tide is actually propagated in the Ocean."[6] In other words, he makes it plain that he was basing his map on observations so far as possible rather than on an a priori theory of the tide. He was fully aware of the difficulties involved in securing accurate tide observations and the further difficulties of correcting the data derived from short series of observations to mean values; and he is scrupulously careful to make it clear that he is endeavoring "to draw a first approximation to the course of the cotidal lines, begging the reader to bear in mind that from the nature of our materials it must be imperfect."[7] Finally, in the conclusion to his memoir he adds, "I shall be neither surprised nor mortified if the lines which I have drawn shall turn out to be in many instances widely erroneous; I offer them only as the simplest mode which I can now discover of grouping the facts which we possess."[8]

If there were sufficient tide observations in the open sea the construction of a cotidal map would offer no more difficulty than the drawing of a contour map of a well-surveyed area; but tide observations are confined wholly to the coast line. In Whewell's case the difficulty was aggravated by the absence or meagerness of accurate observations over wide stretches of the coast. Under such conditions some theory of the tide must, obviously, underlie the construction of a cotidal map.

Parenthetically it may be observed that in speaking of a "theory" of the tide no question is raised thereby as to the moon and sun being the agencies that give rise to the tide. Nor is there any question as to the tide-producing forces brought about by the attraction of moon and sun, for these are well known and can be readily determined from known astronomical data. But taking these tide-producing forces for granted, what is the precise nature of the movement of the ocean waters in response to them?

Progressive-Wave Theory

Underlying Whewell's cotidal map is the so-called "progressive-wave" or "Southern Ocean" theory of the tide. This theory con-

[6] *Ibid.*, p. 156.
[7] *Ibid.*, p. 163.
[8] *Ibid.*, p. 235.

siders the tides of the world as due primarily to the action of the tidal forces of moon and sun on the broad and deep waters of the Southern Ocean, the belt of water that completely encircles the earth south of the great land masses. Here it is argued, the tidal forces have almost uninterrupted sway, and here these forces raise two tidal waves 180° apart in longitude, which travel from east to west. As each of these waves sweeps past the Cape of Good Hope it generates a wave which travels up the Atlantic Ocean, and it is this secondary wave generated by the primary tidal wave of the Southern Ocean which determines the tides on the shores washed by the Atlantic.

It is important to note carefully the distinction between the primary tidal wave and the secondary wave which, according to this theory, sweeps up the Atlantic Ocean. The secondary wave travels freely, according to depth. But the primary tidal wave in the Southern Ocean keeps step with the moon; it travels not as a "free" wave, but as a "forced" wave, compelled by the moon to keep in time with its own movement.

At Whewell's instance simultaneous tide observations were made in 1835 at a number of places both in Europe and in America. In reporting on the results of these observations he states, "It is not surprising, therefore, that the differences between the form of the [cotidal] lines now obtained and my former maps should be considerable. At the same time I may observe, that all my views of the general course of the tide-wave have been confirmed by the present examination."[9] As a result of these newer observations he presents a revised cotidal map of the waters around the British Isles, but not for the world at large. It is of interest to note, however, that from the study of these more recent observations Whewell finds a number of difficulties in the notion of the progress of the tide wave from south to north in the Atlantic Ocean.[10]

The progressive-wave theory is very plausible and explains a number of features of the tide as they manifest themselves in the seven seas. To the end of the nineteenth century the greater number of tidal investigators, and in turn the geographers, lent the weight of their authority to the progressive-wave theory and to Whewell's cotidal map. In his article on "Tides and Waves" Sir George Airy, whose contribution to the mathematical development of tidal theory was considerable, directs attention to the fact that the cotidal lines in the other seas cannot be considered as known with great certainty; but with regard to the North Atlantic he remarks, "We conceive therefore (recognizing also the justness of the principles on which Mr. Whewell has generally drawn his curves) that the cotidal lines of the

[9] William Whewell: Researches on the Tides: Sixth Series, *Philos. Trans. Royal Soc. of London*, Vol. 126, 1836, pp. 289–341; reference on p. 294.

[10] *Ibid.*, p. 304.

Northern Atlantic are now drawn with very great accuracy."[11] He reproduces Whewell's cotidal map of the world[12] with the corrections indicated by Whewell in his memoir of 1836. Five years later Heinrich Berghaus reproduces Whewell's map of 1833 with no corrections; he adds, however, cotidal lines for the Pacific Ocean.[13] These latter he draws in dotted lines for distinction from those laid down by Whewell, which are shown in full lines, explaining in a legend that the full lines are certain while the dotted lines are uncertain. Even so late as 1911 Airy's cotidal map is reproduced by Darwin in the third edition of his well known book on the tides,[14] although attention is directed to the assumptions underlying it and to the results of later investigations which call some of these assumptions into question. Darwin goes on to state, however, that "the tide-wave is principally progressive in the ocean."[15]

Stationary-Wave Theory

A body of water disturbed from its condition of rest tends to set up waves. This is a familiar fact illustrated not only by the ocean waves and swells but in a variety of ways—by the pebble dropped in the pond, the wind disturbing the surface of the lake, the boat plowing through the water. And in the same way the tide-producing forces of sun and moon acting on the waters of the sea bring about the mighty wave which manifests itself as the tide.

It is to be noted, however, that a body of water is capable of sustaining two different types of wave movement. If we take a rectangular tank, say about 20 feet long filled with water to a depth of about a foot, we can start a wave by agitating the water at one end with a paddle. This wave will progress from one end of the tank to the other, the outline of the wave being the sinuous curve which we generally associate with wave movement. This wave is technically a progressive wave.

But we may also set up in the tank of water a wave movement of an entirely different kind by raising and then immediately lowering one end of the tank. The water will now no longer progress from one end to the other, but will oscillate or swash about an axis in the middle of the tank, so that it will be high water for half the tank at the same instant that it is low water in the other half. This type of wave is known as the stationary wave.

On the basis of the progressive-wave theory the rise and fall of the tide was conceived as a world phenomenon dominated by the forced tide wave of the Southern Ocean. But a study of the results

[11] Encyclopaedia Metropolitana, Vol. 5, London, 1845, p. 390.*
[12] *Ibid.*, Pl. 6.
[13] Heinrich Berghaus: Physikalischer Atlas: Allgemeiner Hydrographischer Atlas, Gotha, 1850.
[14] G. H. Darwin: The Tides and Kindred Phenomena in the Solar System, 3rd edit., London, 1911, p. 194.
[15] *Ibid.*, p. 198.

of the more numerous tide observations since Whewell's time brings out the fact that, while the characteristic features of the tide in the various oceans differ considerably, for any one ocean basin these characteristic features are much the same. Is it not, therefore, more probable that the tides in the various oceans are brought about by the action of the tide-producing forces on the waters of the individual oceanic basins, each basin responding in accordance with its geographic make-up? Furthermore, may not the rise and fall of the tide in the open ocean be due to a stationary wave rather than to a progressive wave?

From time to time various investigators had put forward the suggestion that certain features of the tide could best be understood on the assumption that the response of the waters to the tidal forces of sun and moon was of a stationary-wave character. Indeed, Whewell himself, some fifteen years after the publication of his cotidal lines thinks it unlikely that the progressive wave in the Atlantic and Pacific Oceans which his scheme of cotidal lines assumes "rightly represents the mode in which the waters of the Atlantic and Pacific obey the action of the sun and moon" and adds, "If it be asked what other mode of operation of the lunar and solar forces upon the ocean can be conceived, different from this progressive wave which is expressed by means of cotidal lines; an answer immediately suggests itself, that a *stationary undulation* . . . is a possible mode of motion for a fluid under such circumstances."[16]

As a result of his later researches Whewell is "disposed to retract parts of what I have said with regard to the form of the cotidal lines of the Atlantic in my 'Essay.' I do not think it likely that the course of the tide can be rightly represented as a wave travelling from south to north between Africa and America."[17] For the wide expanses of the open sea Whewell definitely discards the cotidal lines previously laid down by him. It is a curious fact, therefore, that despite this his cotidal map was reproduced in various books for many years thereafter.

Stationary-wave movements as related to tides received considerable mathematical discussion in the tidal researches of William Ferrel. He concluded that the tide in the North Atlantic Ocean was due primarily to an east-and-west stationary-wave oscillation. He discarded completely the notion of a progressive wave sweeping up the Atlantic from the Southern Ocean and emphasized his views by the statement, "If there were a dike extending from the Cape of Good Hope to the coast of South America, the tides of the North Atlantic Ocean would most probably be very nearly the same."[18]

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[16] William Whewell: Researches on the Tides: Thirteenth Series, *Philos. Trans. Royal Soc. of London*, Vol. 138, 1848, pp. 1–29; reference on p. 3.

[17] *Ibid.*, p. 5.

[18] William Ferrel: Tidal Researches, Appendix, *U. S. Coast Survey Rept. for the Year 1874*. Washington, 1874, p. 239.

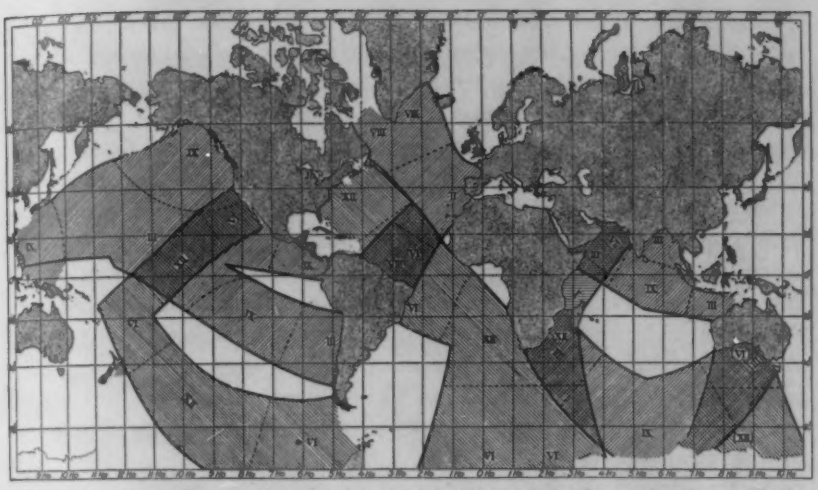


FIG. 3—Oceanic oscillating systems for the semi-daily tide-producing forces, according to Harris.

OCEANIC OSCILLATING SYSTEMS

It was however, not till the beginning of the present century that the stationary wave was made the basis of a full-fledged theory of the tide. In 1901 Harris published his "Outlines of Tidal Theory."[19] This is primarily a mathematical discussion of the modes of oscillation of bodies of water. Harris' thesis is that the tide in the open sea is brought about by stationary-wave movements of various oceanic areas which he denominates as "oscillating systems," these systems having free periods of oscillation which are approximately the same as the periods of the tide-producing forces.

The period of oscillation of a body of water depends on its length and depth. Since the principal tidal forces are those having a period of half a lunar day, Harris separated out oceanic areas which have the requisite length and depth to support stationary waves with a period of half a lunar day. These oceanic areas constitute the "oscillating systems" and are illustrated in Figure 3.

The Roman numerals on the oceanic oscillating systems of Figure 3 give the cotidal hours over the areas indicated. Several of the oscillating systems overlap, and these are distinguished by different kinds of shading. The nodal lines of the various systems are indicated by dashed lines across the shaded areas. The unshaded parts of the ocean are areas of such size and depth that the action of the tide-producing forces on these areas can produce but little tide. In such regions, therefore, the tides that occur are due to the tides produced in the neighboring oscillating areas.

[19] R. A. Harris: Manual of Tides, Part IVA: Outlines of Tidal Theory, *U. S. Coast and Geodetic Survey Rept. for the Year Ending June 30, 1900*, Washington, 1901, pp. 535–699 (Appendix No. 7).

According to the stationary-wave theory, the tide-producing forces of sun and moon as they sweep over the oceans maintain a stationary-wave oscillation in these open ocean systems, the rise and fall being greatest at the ends and least at the nodal lines. These oscillations give rise to the dominant semidaily tides of the world. Openings in the coast line and irregularities in depth cause the stationary-wave tides generated in these ocean basins to send off progressive waves into coastal tidal waters, or into other parts of the sea.

South of Australia, Figure 3 shows an oscillating area in which the cotidal hours are enclosed in parentheses. This area lying between Australia and the Antarctic Continent is of such length and depth that its period of oscillation is more nearly that of the solar tide-producing forces than of the lunar. Consequently, the tides here should show a relatively large solar constituent. And the results of analyses of tide observations made on the southern coast of Australia prove this to be the case.

A number of puzzling features of the tide in various regions are explained nicely by the stationary-wave theory. Such diverse manifestations of the tide as the relatively large rise and fall on the Atlantic coast of the United States as compared with the small range on the Bahamas and Porto Rico, the small diurnal inequality in the Atlantic Ocean tides, the surprisingly large ratio of the solar to the lunar tide at Tahiti—these phenomena find ready explanation under the stationary-wave theory and Harris' conception of oceanic oscillating systems.

Criticism of Harris' theory has not been wanting. G. H. Darwin, reviewing the "Outlines of Tidal Theory," dissented absolutely from Harris' views and found himself constrained to criticize it adversely.[20] In his "Handbuch der Ozeanographie" Krümmel discusses the oscillating systems and concludes, "Such a conception is mathematically possible, but from our geographic point of view we are compelled to reject these oscillating systems of Harris decisively."[21]

In this connection it is to be observed that the mathematical basis of the theory deals with difficult hydrodynamical questions. The criticism of so well-known an authority as Darwin carried great weight, and his adverse criticism undoubtedly did more than any other cause to bring Harris' theory into disfavor. But in 1910 Poincaré published the third volume of his "Leçons de Mécanique céleste," devoted to the tides. After subjecting the various tidal theories to searching mathematical analyses the great master states "It is probable that the final theory will have to borrow from that of Harris a notable part of its principal features."[22] Poincaré's exposition of Harris' theory has done much to bring it to the fore again.

[20] G. H. Darwin: A New Theory of the Tides of Terrestrial Oceans, *Nature*, Vol. 66, 1902, pp. 444–445.

[21] Otto Krümmel: Handbuch der Ozeanographie (2 vols., Stuttgart, 1907–1911), Vol. 2, p. 256.

[22] Henri Poincaré: Leçons de Mécanique céleste (4 vols., Paris, 1905–10), Vol. 3, p. 403.

Harris' Cotidal Map

On the basis of a careful synthesis of the results of the tide observations made to the beginning of the present century, Harris constructed a cotidal map of the world, in which the course of the cotidal lines in the oceanic areas were drawn in consonance with his tidal theory.[23] This map differs radically from Whewell's, as may be seen on comparing the cotidal lines of the Atlantic Ocean in Figures 2 and 4, the former illustrating the cotidal lines according to Whewell and the latter according to Harris.

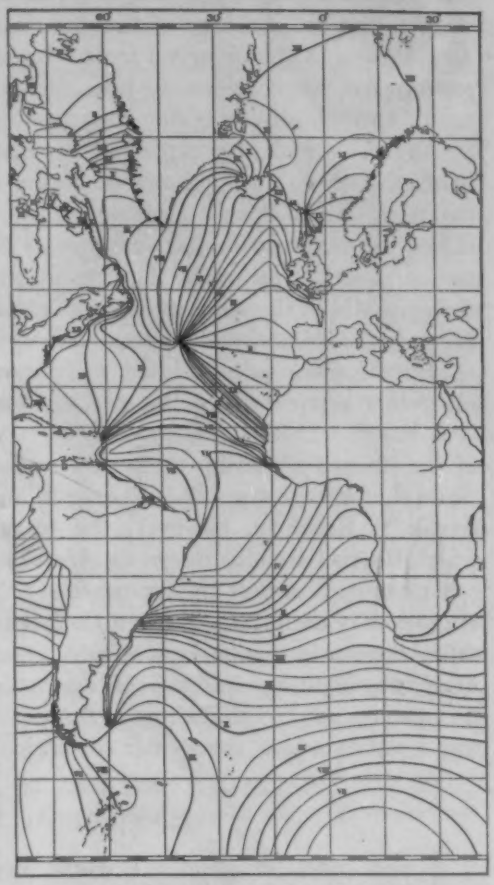


Fig. 4—Harris' cotidal map of the Atlantic Ocean.

Along the coast the differences between Whewell's and Harris' cotidal maps arise from the fact that Harris had at his command the results of more numerous and more accurate tide observations. But the most striking differences are not near the coast but in the open ocean. Taking the North Atlantic Ocean, in Whewell's map the tide is shown progressing in a simple manner. In Harris' map there is no such simple progression; instead, there is a point about which the cotidal lines radiate. Such points Harris designated by the name of "amphidromic points."

As to the causes that bring about amphidromic points, or points of no tide, it is to be remembered that in a stationary wave no rise and fall takes place along the nodal line; hence in a simple stationary-wave movement there is a *line of no tide*. Now suppose that in a body of water there are two simple stationary waves, one in an east-and-west direction, and the other in a north-and-south direction. The first wave gives rise to a line of no tide in the north-and-south direction while in the other wave

[23] R. A. Harris: Manual of Tides, Part IVB: Cotidal Lines of the World, *U. S. Coast and Geodetic Survey Rept. for the Year Ending June 30, 1904*. Washington, 1904. Fig. 6, opp. p. 400.

the line of no tide runs in an east-and-west direction. Where the two lines cross there will manifestly be a *point of no tide;* and a little consideration will show that from this point the cotidal lines will radiate.

In the interest of historical accuracy it is to be mentioned that the concept of a no-tide point had been put forward by Whewell in 1836 to explain the behavior of the tides in the North Sea.[24] However, this was done not on the basis of dynamic principles or in consonance with a particular theory of the tide but to give the most likely interpretation of the observed facts. Later, in discussing types of tidal movements, he mentions the possibility of an oceanic tidal movement with "cotidal lines revolving round a fixed center."[25]

On his cotidal map of the world, Harris places two amphidromes in the North Atlantic (shown in Figure 4), one in the North Pacific, two in the South Pacific, and one in the Indian Ocean. Because of the difficulties involved in the observation of tides in the open sea there are no practical means at the present time for proving or disproving the existence of these oceanic amphidromic points. But on theoretical grounds the existence of these no-tide points appears unquestioned.

Harris' name is associated with another tidal question which is altogether separate from his cotidal map and the theory on which it is based. This is the question of land in the unexplored regions of the Arctic. From his study of Arctic tides Harris was led to conclude that a large tract of land existed in the unexplored region of the Arctic.[26] Recently, however, the features of the Arctic tides on which Harris based his inference of land have been shown to be due to other causes,[27] so that the existence of a large land mass in the Arctic appears very doubtful and can no longer be said to be indicated by the tides. It must be emphasized, however, that this inference of land in the Arctic was in no way based on his stationary-wave theory of the tide in the open ocean, and the failure to find an Arctic land mass would in no way invalidate that theory nor the cotidal map based thereon.

Recent Cotidal Maps

A new cotidal map of the world was published by Dr. Robert Sterneck in 1920.[28] It was based on the fact that an oscillation may be conceived as arising from the interference of two components with phase differences of one-quarter period. This greatly simplifies the mathematical treatment, and on the basis of the actually observed tides along the various coasts and islands Sterneck constructs his

[24] Article cited in footnote 9, p. 298.

[25] Article cited in footnote 16, p. 5.

[26] R. A. Harris: Arctic Tides, Washington, 1911.

[27] H. U. Sverdrup: Dynamic of Tides on the North Siberian Shelf: Results from the Maud Expedition, *Geofys. Publikasjoner*, Vol. 4, No. 5, Norske Videnskaps-Akad. i Oslo, 1926.

[28] Robert Sterneck: Die Gezeiten der Ozeane, *Sitzungsber. Akad. der Wiss. in Wien, Math-naturw. Klasse*, Abteil. IIa, Vol. 129, 1920, pp. 131–150.

map in consonance with hydrodynamic principles. He finds it necessary to place two amphidromes in the Atlantic Ocean, six in the Pacific Ocean, and four in the Indian Ocean. In other words, he has the same number of amphidromic points as Harris in the Atlantic, three more in the Pacific, and three more in the Indian Ocean. Sterneck's cotidal map for the Atlantic is reproduced in Figure 5.

More recently Prof. Defant has drawn a cotidal map for the Atlantic and Arctic Oceans.[29] Starting from the consideration that the Atlantic and Arctic Oceans constitute an enormous canal open only at its southern end—since, in comparison, the narrow and shallow Bering Strait on the north may be totally disregarded—Defant studied mathematically the various oscillations which such a canal can sustain and the relative importance of these various oscillations in bringing about the actual tide. He found that it is the north-and-south stationary-wave oscillation that determines the tide in the Atlantic Ocean.

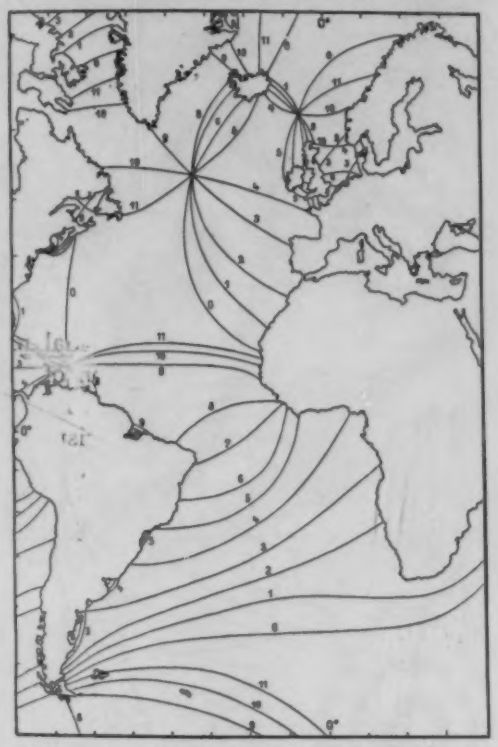


FIG. 5—Sterneck's cotidal map of the Atlantic Ocean.

Defant's mathematical analysis indicates the existence of six primary nodal lines in the canal made up by the Atlantic and Arctic Oceans. The effect of the earth's rotation and of cross oscillations is to eliminate two of these nodal lines and to convert the other four into amphidromic points as shown in Figure 6, which is a reproduction of Defant's map. For the greater part of the Atlantic Ocean the tide behaves as if it were a progressive wave coming from the Southern Ocean; but Defant emphasizes the fact that it is only an appearance, due to the interaction of north-and-south and east-and-west oscillations and not to an actual progressive wave sweeping northward from the Southern Ocean.

Comparing Defant's cotidal map of the Atlantic with those of Har-

[29] Albert Defant: Die Gezeiten des Atlantischen Ozeans und des Arktischen Meeres, *Annal. der Hydrog. und Marit. Meteorol.* Vol. 52, 1924, pp. 153–166.

ris and Sterneck shown in Figures 4 and 5, a close family resemblance appears, especially in the recognition of the existence of amphidromic points. This is all the more striking since each of these three investigators starts from different theoretical considerations. It may therefore be taken for granted that these cotidal maps represent, in the large at least, the movement of the tide across the open sea.

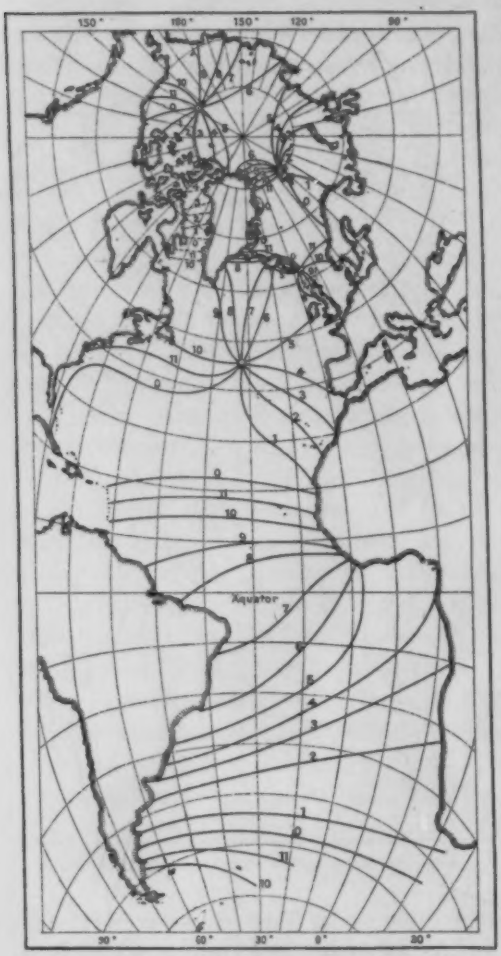


FIG. 6—Defant's cotidal map of the Atlantic Ocean.

The latest cotidal map of the world to date is by Dr. T. J. J. See, who in a recent publication devoted to tides puts forward "a revised cotidal map of the oceans."[20] This is a revision of Whewell's cotidal map and, like the latter, pictures the tide as progressive waves traversing the open sea. Neither Whewell's own objections to this conception nor the criticisms of later investigators appear to have any weight with Dr. See.

Brushing aside the work of Ferrel, Harris, Poincaré, Sterneck, Defant, and other tidal students, Dr. See sets up a new "wave theory" of the tide; but, although making use of considerable mathematical scaffolding, it is unconvincing. Indeed, it has been very severely criticized in a review by Dr. J. Proudman[21] who speaks as a tidal mathematician of recognized authority. Dr. See's cotidal map runs so completely counter to the results of all other tidal investigators of the present time that the author's reputation in other fields cannot be taken as surety for the validity of the mathematical reasoning he advances in support of his thesis.

[20] T. J. J. See: New Dynamical Wave-Theory of the Tides, *U. S. Hydrogr. Office Publ. No. 207*, Washington, 1926.

[21] *Geogr. Journ.*, Vol. 69, 1927, p. 588–589.

Semidaily Versus Daily Tides

The principal tide-producing forces are those having a period of half a day; and it is for this reason that the tide, the world over with but few exceptions, has a period of half a day. Cotidal maps picturing the tide as it actually takes place, or those based wholly on the semidaily constituents of the tide are practically indistinguishable.

For certain purposes, however, it is important to have cotidal maps of the daily tide. By means of the mathematical process known as harmonic analysis[32] the observed tide at any place may be resolved into its simple constituents. And it is on the results of harmonic analysis that cotidal maps for the daily tide are based. Sterneck has published a cotidal map of the daily tide for the world at large,[33] and Defant one for the Atlantic and Arctic Ocean.[34] In both of these maps amphidromic points constitute the basic features.

[32] See, for example, Paul Schureman: A Manual of the Harmonic Analysis and Prediction of Tides, *U. S. Coast and Geodetic Survey Special Publ. No. 98*, Washington, 1924.

[33] Robert Sterneck: Die Gezeiten der Ozeane, *Sitzungsber. Akad. der Wiss. in Wien, Math.-naturw. Klasse*, Abteil. IIa, Vol. 130, 1921, p. 372.

[34] Defant, *loc. cit.*, opp. p. 200.

AMERICAN GEOGRAPHICAL SOCIETY

The November Meeting. The first regular meeting of the American Geographical Society for the season 1927–1928 was held on November 22, 1927, at the Engineering Societies Building, 29 West 39th Street, President John H. Finley in the chair. Mr. George Palmer Putnam spoke on "Exploration in Baffin Island," illustrating his lecture with motion pictures. The work of his expedition is described in this number of the *Geographical Review*.

Elections to Fellowship. At the November meeting of the Society, President Finley presiding, there were presented with the approval of the Council the names of 522 candidates who were duly elected as Fellows of the Society.

Expeditions

The American Geographical Society's Peruvian Expedition. In June the Society sent an expedition to Peru under the direction of Mr. O. M. Miller, of the Society's School of Surveying, to make a topographic survey of the headwater region of the Marañón River in the cordillera of the Andes northwest of Cerro de Pasco and to carry out a number of traverses in the montaña between the Marañón and Huallaga Rivers. The purpose of the expedition was to fill one of the most important gaps in the collection of source material which the Society is assembling for the compilation of its Map of Hispanic America on the scale of 1:1,000,000 and to link together a number of earlier surveys collected from various sources. In a report received October 20, Mr. Miller stated that the survey work in the cordillera had been completed, approximately 1500 square kilometers having been covered by triangulation and topographic surveys supplemented by a large number of photographs and moving pictures.

The Peruvian government has shown much interest in the expedition, has furnished it with a military escort, and has otherwise greatly facilitated its work.

Mr. Joseph H. Sinclair's Expedition to the Ecuadorean Oriente. Mr. and Mrs. Joseph H. Sinclair sailed for Ecuador on August 20 to carry out an important program of exploration and geographical studies in the Ecuadorean Oriente in collaboration with the American Geographical Society. They will continue the surveys and geological reconnaissance work begun by Mr. Sinclair and Mr. Theron Wasson in 1921. (See Joseph H. Sinclair and Theron Wasson: Explorations in Eastern Ecuador, *Geogr. Rev.*, Vol. 13, 1923, pp. 190–210.) The special objective of the expedition is Mt. Sumaco, a volcano which was located by the expedition of 1921 and which the present expedition proposes to study and map. The surveys will be an important contribution to the Society's Map of Hispanic America.

The government of Ecuador is much interested in the objects of the expedition and has greatly assisted Mr. Sinclair in his preparations for the trip.

Recent Publications

Arabia Deserta: A Topographical Itinerary. This book is Number 2 of the Society's series *Oriental Explorations and Studies*, the first six numbers of which are being published "under the patronage of the Czech Academy of Sciences and Arts and of Charles R. Crane, Esq.," and will comprise the scientific results of Professor Alois Musil's explorations in northern Arabia and Mesopotamia (see *Geogr. Rev.*, Vol. 15, p. 297; Vol. 17, pp. 145, 178).

"Arabia Deserta" deals specifically with the region known to the ancient geographers by that name, the great expanse of stony and rocky deserts and steppes lying between the Hauran Mountains and Wadi Sirhān on the west, the Euphrates on the northeast, and the Nefūd sands on the south. Between November, 1908, and June, 1909, Musil wandered widely over this region, some of the time in company with the Rwala Bedouins, whose head chief, An-Nūri, was his "friend and brother." In 1912 he cut across a part of the eastern edge of Arabia Deserta between Ar-Rumādi and An-Nejef. In December, 1914, and January, 1915, he made his way from Damascus to Al-Jauf, on the first lap of an extended journey in Nejd and Mesopotamia which will be described in detail in subsequent volumes.

To each of these three expeditions is devoted a separate part of the main text of "Arabia Deserta." In addition to the strictly topographical information about the country lying along the author's routes, the narrative is enlivened by many anecdotes which illustrate life in the desert and the mentality of the nomads.

In the appendixes the author deals critically with questions of historical and archeological interest: northern Arabia in the Assyrian period; the Bene Qedem; Arabia Deserta according to the classical and Arabic authors; ancient, medieval, and modern transport routes in Arabia Deserta; various episodes in the history of the oasis of Dūmat al-Jandal (al-Jauf); and the march of the Moslem general Khaled ibn al-Walīd from Iraq to Syria in the dramatic campaign of 13 A. H. (634 A. D.).

The volume is illustrated with some very striking photographs as well as with plans of certain ruins visited by the author.

Map of Northern Arabia 1:1,000,000. This map (in four sheets, printed in black and brown) embodies the results of Professor Alois Musil's explorations of 1908–1915 in Palmyrena, the north Arabian (or Syrian) desert, northern Nejd, and the northern Hejaz; it illustrates Musil's volumes "Arabia Deserta," "The Middle Euphrates," "Palmyrena," and "Northern Neǧd" being published by the Society (see preceding note). The skeleton of the map is based upon astronomical determinations of position, plane-table surveys, and route traverses. Topographical features away from Musil's routes were drawn from information derived from sketch maps and descriptions supplied by the natives. In the expression of the relief and in the recording of place names the map reveals fuller detail than any map that has hitherto been published of the regions in question.

The Leardo Map of 1452 or 1453. In 1906 Archer M. Huntington, Esq., presented to the American Geographical Society a fifteenth-century parchment map of the world (*Bull. Amer. Geogr. Soc.*, Vol. 38, 1906, pp. 365–368) which had been brought to light in 1879 by an Austro-Hungarian diplomat, Major Friedrich von Pilat. The map, signed by Giovanni Leardo, the Venetian, and dated either 1452 or 1453, combines several unusual elements. A series of concentric circles forming a calendar of saints' days together with lunar and solar almanacs surrounds a circular disk on which are depicted lands and seas, rivers, mountains, and towns. Many place names drawn from various sources are of interest to students of the history of geography. In the general arrangement of the features shown and in the pleasing color schemes the map forms a work of art of no little decorative value.

A full-size colored reproduction of this map has been made for the Society by the firm of A. Hoen & Co., Baltimore, and is now ready for distribution. The reproduction is accompanied by a small illustrated book in which Dr. J. K. Wright, Librarian of the Society, explains the map. The book may be purchased separately by students who do not wish to buy the reproduction.

Distribution of Title Page, Contents, and Index of Volume 17 of the Geographical Review. The title page, table of contents, and index for Volume 17 of the *Geograph-*

ical Review (1927), which is issued separately, is ready for distribution. Copies are sent to all institutions exchanging publications with the Society and to individuals who request that their names be put on a list for this purpose.

The Death of Professor William Libbey. Professor William Libbey, Councilor and Foreign Corresponding Secretary of the Society, died at his home in Princeton, N. J., on September 6, 1927, in his 73rd year. The Council at its monthly meeting of November 17 passed a resolution of sympathy thereon.

Dr. Libbey was professor emeritus of physical geography at Princeton University with which institution he had been long associated. For 40 years he acted as director of the museum of geology and archeology. In his student days he worked under Guyot, and his first contribution to the *Bulletin of the American Geographical Society* was an appreciation of "The Life and Scientific Work of Arnold Guyot" (Vol. 16, 1884, pp. 194–221). He also edited the revised edition (4th) of Guyot's "Tables, Meteorological and Physical" (*Smithsonian Misc. Colls. No. 538*), published in 1884.

In the summer of 1886, with Lieutenant Schwatka, Professor Libbey explored the country about Mt. St. Elias, of which he furnished an enthusiastic description, "Some of the Geographical Features of Southeastern Alaska," to the Society's *Bulletin* (Vol. 18, 1886, pp. 279–300). Twice he visited Greenland: on the first occasion as geographer of the Peary Auxiliary Expedition of 1894 commanded by Mr. Henry G. Bryant (see *Bull. Geogr. Club of Philadelphia*, Vol. 1, 1893–1895, pp. 141–215), and again in 1899 as leader of the Princeton Scientific party on the Peary Club's relief ship *Diana* (see *Bull. Amer. Geogr. Soc.*, Vol. 32, 1900, pp. 245–248). His chief expedition, however, was that to the Holy Land undertaken with Dr. F. E. Hoskins of the Beirut Mission in 1902. The narrative of the trip is given in two finely illustrated volumes "The Jordan Valley and Petra" (1905).

For several years Professor Libbey carried out oceanographical investigations off the New England coast for the U. S. Fish Commission, the major results of which are given in a report before the Sixth International Geographical Congress held in London, 1895 ("The Relations of the Gulf Stream and the Labrador Current"). It was in recognition of his work that Sir John Murray named one of the North Atlantic deeps off that coast the "Libbey Deep." Similarly in appreciation of seismic data collected by Professor Libbey, Milne named the "Libbey Circle," a circle which he describes as of radius 70° centered 180° longitude and 60° N. latitude (*Rept. British Assn. for the Advancement of Sci. for 1904*, p. 44), the median line of a great fracture zone.

Professor Libbey was an Officer d'Académie of France and a member of many learned institutions. He also devoted much time to patriotic and civic services.

GEOGRAPHICAL RECORD

NORTH AMERICA

Some Official Explorations in the Canadian Arctic Archipelago. The great unknown interior of Baffin Island has lately attracted official attention in Canada. In addition to the regular police patrols several scientific trips have been undertaken (see the Reports of the Royal Canadian Mounted Police for 1924–1925 and 1925–1926 and the Report of the Department of Mines for 1925–26). In July, 1924, Mr. J. D. Soper took up headquarters at Pangnirtung, the post on Cumberland Sound, to make natural history collections for the National Museum at Ottawa. The following April in company with a member of the patrol he set out for Lakes Nettilling (Netsalik) and Amadjuak, "said to be the nesting place of the blue goose," following the route traversed by Hantzsch in 1910. They proceeded up Nettilling Fiord, crossed the divide between Cumberland Sound and Foxe Basin, "rugged country with heights up to 5000 feet," to the eastern shore of Lake Nettilling. Here elevations were about 400 feet, the surface of the lake itself being about 85 feet. After the break-up of the ice in early August the southern shore of the lake was followed to the mouth of the Amadjuak River. West and north stretched a broad flat plain with "a large light colored hill on the horizon" (300 to 400 feet). In the vicinity were many ancient stone walls and tupik rings. The Eskimo apparently came here from the south coast for the summer caribou hunt. Few traces of caribou, however, were seen: Mr. Soper notes that enormous numbers have been killed off since the introduction of the rifle.

The western shore of the lake, low lying and fringed with gravel reefs thrown up by the ice, was followed to the mouth of the Koukjuak River, and this stream was descended for ten miles. The Koukjuak is described as shallow, one to three miles wide, and flowing with a current of three miles an hour over a limestone bed. The surrounding country is "flat and swampy, the beaches rich in fossils": to the north is a low range of hills. Caribou appeared more plentiful here. The return to Pangnirtung was made over the same route.

A communication from the Geological Survey of Canada gives a summary of Mr. Soper's work in 1926. He left Pangnirtung on January 9, and with two Eskimos crossed the interior of Baffin Island via Lake Nettilling to Foxe Basin, which was reached February 2. On the return trip he completed his map of the north side of the lake. He found the country west of Lake Nettilling and north of Koukjuak River very flat and destitute of game in winter. These surveys show that the lake is considerably smaller than previously indicated on maps and that the Foxe Basin coast lies at least 43 miles farther to the east than was formerly supposed. In March Mr. Soper made a 400-mile trip to Lake Nettilling to bring out the scientific collections of 1925 and to make a cache at the mouth of Amadjuak River. He left Pangnirtung again April 11 and traveled 380 miles by sled, reaching Amadjuak Bay April 26. On the way he visited the limestone escarpment on the west side of Amadjuak Lake. Part of this latter trip was over the course traversed by Major L. T. Burwash, exploratory engineer of Northwest Territories and Yukon branch in 1924, but some new mapping was done on the small lake system south of Amadjuak Lake. From Amadjuak Mr. Soper went to Cape Dorset, 125 miles. A report of Mr. Soper's work, with maps, is now in preparation.

Between February 15 and May 2 of 1926, two members of the police patrol made an overland trip 1300 miles in length from Pangnirtung to the new post at Lake Harbour on the southern coast. As far as the mouth of the Amadjuak River the

route lay over the ground traversed by Mr. Soper the preceding year; thence it was up the river, a winding rapid stream averaging 200 feet in width. The course of this open water was visible from a long distance by the cloud of vapor rising from it. There are falls on the river just above the entrance to Lake Nettilling and again midway up the stream. Three prominent limestone cliffs or escarpments were noted as landmarks on the west side of Lake Amadjuak. Lake Mingo was passed, and high granite ranges were crossed to the coast. Serious errors were found in the delineation of the large lakes on the "Map of the Northwest Territories for 1924." The patrol observes that caribou cannot be depended on and comments on the fact that Dr. W. T. Lopp was spending the spring in the interior of the Amadjuak post region in search of feeding grounds for the Hudson Bay Reindeer Company. Of the herd of 550 reindeer landed at the post in 1921 not one animal survives.

In 1926 and 1927 Dr. L. J. Weeks, of the Canada Geological Survey, undertook an extensive mapping program in the northern portion of Cumberland Sound, carrying a traverse through a chain of small lakes to Lake Nettilling and along its southern shore. Publication of his maps will be awaited with interest.

Starting in February, 1927, Dr. L. D. Livingstone, medical officer in the Canadian Arctic Archipelago, made a 51-day trip from Pangnirtung, via Frobisher Bay and overland to Lake Harbour, then west 130 miles to Amadjuak, along the southern shore of the lake and by a new route following an uncharted river to Cumberland Sound (*Nat. Resources, Canada*, Oct. 1927). Shortly after his return he set out for Ponds Inlet, the post on the northern coast of Baffin Island. Near Ponds Inlet the coast was found to be badly charted. In the course of his patrols Dr. Livingstone made an estimate of the native population and gathered information on the living conditions. His report on their health and well being appears to be generally favorable.

Among other notable journeys accomplished in 1926 as part of the routine work of the police in the far north was a 900-mile patrol from Ponds Inlet to the eastern coast of Baffin Island (Home Bay), while the officer at Craig Harbour traveled to Axel Heiberg Island by way of Jones Sound and the west coast of Ellesmere Land, a total of 975 miles, in 40 days. In 1927 a 1320-mile patrol was made in 54 days from the new post at Bache, in latitude 79° N. (for an account of the post see "Canada's Arctic Islands: Canadian Expeditions 1922 and 1923, J. D. Craig, 1924, F. D. Henderson, 1925 and 1926, G. P. Mackenzie," Dept. of the Interior, Ottawa, 1927), to Axel Heiberg and other islands to the west. This journey was notable for the quantity of game encountered, especially musk oxen, and a discovery of coal on Bay Fiord.

Survey of Great Slave Lake Region. Recent surveys have made striking changes in the topographic map of the Great Slave Lake region of Canada. Although the route to the Arctic via Lake Athabaska, Great Slave Lake, and the Mackenzie River has long been traveled, knowledge of the country east of Great Slave Lake was, until recently, based chiefly on a map drawn from memory by Samuel Hearne who crossed it in 1772. Discovery of oil on the Mackenzie River led in 1921 to the first of a series of surveys in this region. A control party passed through Great Slave Lake and down the Mackenzie in that year.

In 1922 the east end of the lake was explored. Surveys on the North Arm in 1923 revealed several important portages to the Arctic. Early in the following year, work on the ice determined the positions of islands in Great Slave Lake itself; and later an examination was made of the lakes lying to the north of McLeod Bay. A pamphlet "Great Slave Lake Area, Northwest Territories," by G. H. Blanchet (Canada Dept. of the Interior, North West Territories and Yukon Branch, 1926), gives a general description of the country covered by these surveys and discusses the present condition of communication and settlement.

In 1925 the Taltson River and Nonacho Lake were surveyed, Nonacho Lake being considerably altered on the maps as a result. The upper Taltson River and Lake Eileen, probably the source of the Thelon River, were mapped; and a return to Great Slave Lake was made by the hitherto unexplored Snowdrift River (*Nat. Resources, Canada*, Feb., 1926, p. 3.) In 1926 the Abitau River, a newly discovered tributary of the Taltson-Tazin river system, was explored; and the Thele-aza River of Hearne's map was rediscovered and proved to be the headwaters of the Dubawnt River, rather than those of the Thelon River as had been supposed. (*Nat. Resources, Canada*, May 1927, p. 2.) Mr. G. H. Blanchet, who has been in charge of these surveys, describes his work of 1926 in the *Bulletin of the Geographical Society of Philadelphia* for October, 1927.

Rain-Bearing Winds in the Western United States. In view of their importance in connection with weather forecasting, and also in relation to climate, it is rather surprising that so little attention has been paid to the directions of rain-bearing winds in the United States. These directions depend upon the location of the source of water vapor; the nature of the intervening country; the cyclonic tracks; local topography; and other controls. In a recent number of the *Monthly Weather Review* (Vol. 55, 1927, pp. 228–233) Thomas R. Reed discusses "Rain-Bearing Winds in the Far Western States" and gives an interesting set of diagrams of rainfall percentages for each of the eight compass points, and for the various months of the year, at first-order Weather Bureau stations in the San Francisco forecast district. The data cover the ten-year period 1916–1925, except in the case of Spokane, where only a five-year record was available. There are 21 stations in all—in Washington, Oregon, California, Nevada, and Idaho.

The dry season rainfall is so infrequent over this great area that, with only ten years of record, the data for the dry months are not to be relied upon. The most striking fact in the tables and diagrams is the preponderance of precipitation with south winds. When the rain-bearing winds have other directions, the explanation is doubtless to be sought in topographic controls. Precipitation is infrequent with east winds, and when it occurs, as it does in some cases, the explanation is again doubtless topographic. Thus, at North Head and Portland, Ore., a small percentage of easterly rainy wind is probably connected with the proximity of the Columbia River gorge, which forms an east-west gap through the mountains.

At Los Angeles the winds from the ocean (S. W.) are not the rainy winds, but easterly and northeasterly winds bring rain in nearly all months and exceed other directions in rain frequency in the majority of cases. Similar conditions, although somewhat less marked, are seen at San Diego. Reed believes that this anomaly is probably due to "the formation of some sort of eddy conforming in a general way to the axes of the principal ranges." Two stations, Baker and Boise, also for local topographic reasons, have rain from north and northwest. In the Sacramento Valley there is comparatively little rain with northwest winds, which are downslope winds (Red Bluff and Sacramento), while in the San Joaquin Valley (Fresno and San Jose) northwest winds are upslope winds and bring a moderate proportion of moisture.

The generally meager rainfall with westerly surface winds, it is suggested, may be due to the fact that the wind aloft is usually northwest at those times. A northwest wind, aloft, would parallel many of the mountain ranges and reach others at a rather small angle. The opposite would be true of southerly winds. An examination of the isobaric charts for a wet and for a dry October in the far western states shows that for the former the trend of the isobars indicates a preponderance of southwest winds in the free air; while, for the dry month, winds from northerly quarters are indicated aloft. In the wet month the Pacific high-pressure system lay far to the west, and winds from the southwest (rainy) quarter had free access to the lower latitudes. In the dry month, the oceanic high pressure system had an abnormal position, its axis

being prolonged in a northeasterly direction up the Pacific coast, implying a displacement of the southwesterly air currents into high latitudes.

R. DEC. WARD

EUROPE

The Decline of Transhumance in Rumania. Well down into the nineteenth century shepherds with their flocks from the commune of Săliște, which lies on the north slope of the southern Carpathians, might be seen during the autumn and winter filing along the dusty roads of the Wallachian and Moldavian plains, or even crossing the broad steppes of the Dobruja beyond the Danube. In summer they would retire to the high mountain pastures. On the days of St. John (June 24), St. Peter (June 29), and St. Elias (July 21) a picturesque "festival of the heights" was held. "When the mountains were carpeted with flowers, on the clearings at certain summits . . . which form the meeting places of several pastoral regions, young and old would assemble from the *stâna* (chalets) of an entire mountain massif to pass the day in making each other's acquaintance, singing, dancing, offering libations, and even in exchanging merchandise and celebrating weddings."

This colorful shepherd life with its characteristic and highly developed practice of transhumance is on the decline throughout the southern Carpathian region. A variety of circumstances has brought this about, primarily: the occupation of the Wallachian plain by an agricultural population, an economic war between Austria-Hungary and Rumania (1886–1900), and the closing for a time of the Carpathian frontier. At present most of the "old shepherds of Săliște, forced to sell their great flocks, have taken up itinerant or fixed trading, have established themselves in the towns of Wallachia, have bought or sold land in Dobruja, and have become artisans despite their former abhorrence of this occupation."

The pastoral life of Săliște and of several neighboring communes is made the subject of a monograph by Nicholas Dragomir in the second volume of "Lucrările Institutului de Geografie al Universității din Cluj" (Travaux de l'Institut de Géographie de l'Université de Cluj (Roumanie)), pp. 193–257. The first volume of this series, which appeared in 1922, contained the published results of the geographical excursions conducted by Professor Emmanuel de Martonne in Rumania in the summer of 1921. Besides Dragomir's study, Volume 2 includes a group of papers on historical, human, regional, and physical geography which clearly show us that De Martonne's former pupil, Professor G. Vâlsan, has developed at the University of Cluj an institution where geographical research is being conducted in conformity with the fine traditions of the modern French school.

Movements of Population in Calabria. In the *Review* for October, 1927, Professor J. W. Goldthwait told the story of a New Hampshire town that has "gone downhill." He showed how the upland farms had been abandoned one after another during three quarters of a century, until by 1925 the "tide of humanity" had "drawn down to the 1100-foot contour, leaving" all above that level "a silent wilderness." Gradual displacements of long-established agricultural populations are also taking place in different parts of Europe. An interesting case of a downhill movement in the French Alps was recently discussed by D. Mouralis in the *Revue de Géographie Alpine* (Vol. 12, 1924, pp. 547–644; see *Geogr. Rev.*, Vol. 16, pp. 313–315). Similar movements in Calabria have of late been investigated by Salvatore Pagano, who presents his results in an article entitled "Qualche esempio di movimenti di popolazione in Calabria," in *L'Universo*, Vol. 8, 1927, pp. 939–960.

Pagano selected two regions for intensive study: a coastal tract along the Ionian Sea and the valley of the Marepotamo, a short stream which flows parallel to and not far to the west of the main axis of the Apennines. In the former region during

past centuries fear of Saracen and Turkish pirates led to the abandonment of the coastal plain. The inhabitants retired to villages perched on the ridges that form the buttresses of the Apennine chain. Since the early nineteenth century, however, the population has gradually been returning to the coast, attracted by the superior agricultural opportunities afforded on the narrow strip of plain. In the present century the movement has been stimulated by a vigorous campaign waged by the government against malaria. As does Professor Goldthwait for the New Hampshire town, Pagano demonstrates some interesting correlations between the movement of population and the local topography.

In the Marepotamo valley two terraces intervene between the river and the main mountain ridge, the general altitude of the lower terrace being between 250 and 300 meters and that of the upper between 600 and 800 meters above sea level. In the eighteenth century a line of small villages fringed the edge of the lower terrace where it falls off into the gorge of the stream. Generally parallel with this fringe of small villages a line of larger villages followed the upper margin of the lower terrace. During the Napoleonic era brigandage and highway robbery were rife in Calabria. Fear of outlaws led to the abandonment of most of the small villages, their inhabitants retiring to the larger centers. Here they found the protection afforded by numbers and were less exposed to the malaria which lurks in the damp depths of the valley. Furthermore, the inhabitants of one of the abandoned villages moved to a wholly new settlement on the higher terrace. Mountaineers from the Apennines and settlers from the east of the range have also within the last forty years established a number of villages along the upper margin of the higher terrace, where the air is bracing and healthful, where the soil has not been exhausted by centuries of use, and where malaria is almost unknown. Thus in this part of Calabria the tide of settlement is actually flowing up the mountain side.

The Repopulation of the Roman Campagna. In the introduction to his book "The Roman Campagna in Classical Times" (London, 1927) Thomas Ashby points to the transformation now taking place in the countryside about Rome. As Sir Archibald Geikie noted in his essay on "The Roman Campagna" (Landscape in History, 1905) Rome has been unique among the great capital cities in that it stands in the midst of a wide solitude. Since the depopulation that set in with the fall of the Empire and which seems to have attained its worst stages in the seventeenth, eighteenth, and earlier half of the nineteenth centuries, the Campagna has been largely given over to sheep pasture and the temporary occupation of shepherds who come down from the Abruzzi hills in the winter. The woodland of the right bank of the Tiber also had its temporary immigrant occupants, woodcutters and charcoal burners, chiefly from Tuscany.

When Rome became capital of United Italy the population was about a quarter of a million. By the end of the nineteenth century it had approximately doubled, and today it is over 750,000, growing rapidly and spreading beyond the city walls. Malaria control has made possible the reoccupation of the Campagna, and agrarian improvement is playing its part. In the first years of the present century a law was passed to compel landowners in the Agro Romano—the territory of the commune outside of the city limits—within a radius of six miles of the city, to cultivate their land productively under penalty of expropriation. The recent introduction of motor plows and the growth of motor transportation have favored the movement. "Towards the Alban Hills especially there is now only a short interval—and in some places none at all—between the cultivation spreading outwards from Rome and that extending downwards from the hills. New farmhouses are springing up everywhere, and the aspect of the Campagna has completely changed. Whereas twenty years ago the road system resembled a starfish, the main roads being entirely unconnected, it is now more like a spider's web."

AFRICA

The Origin of the Nile Valley in Egypt. The traverse of Africa from Cairo to Victoria Nyanza made in 1926 by Professor A. C. Lawson, of the University of California, gave him opportunity to study the course of the Nile and to propose a new and ingenious explanation for its valley in Egypt (A. C. Lawson: The Valley of the Nile, *Univ. of California Chronicle*, Vol. 29, 1927, pp. 235–259). He recognizes six unlike sections in the 3500-mile length of the river: first, about 500 miles of alternating lakes and rapids below the outlet of Victoria Nyanza; second, 1100 miles of sluggish flow across a vast alluvial plain occupied in its south-central part by the vast papyrus swamp known as the Sudd; third, a great sigmoid double curve about 950 miles in length, at the beginning and end of which stand Khartoum and Wady Halfa where the river flows across a denuded area of crystalline rocks; fourth, a narrow, cliff-bounded canyon of normal erosion in Nubian sandstone; fifth, a cliff-walled trough in the younger limestones and sandstones overlying the Nubian sandstone; sixth, the deltaic course.

There has been much difference of opinion in the last 30 years concerning the origin of the fifth section of the river. Beadnell and Blanckenhorn have argued for down-faulting, while Ball and Hume have contended for river erosion. Lawson decides in favor of down-faulting, largely because he found tilted and depressed masses of the enclosing strata along the margins of the trough. Ball had taken these masses for landslides along the border of a valley of erosion; Lawson finds them too little shattered for landslides and therefore regards them as tilted fault blocks, to which he applies the name of "kernbuts" from his previous study of the geomorphology of a part of the High Sierra of California. The fault trough thus formed contains marine strata overlain by lacustrine deposits; and on these rest extensive detrital fans, washed into the trough from gorges in the enclosing walls and now more or less dissected. It is therefore concluded that, when the region stood lower than now, the down-faulted trough was first occupied by an arm of the sea, then by a body of fresh water; that it next, in consequence of regional elevation, became a dry desert depression, into which the detrital fans were washed by flooded wadies; all this before the Nile was led into the trough by flowing northward over the degraded area of crystalline rocks and across the belt of Nubian sandstone where its canyon is now eroded. Not till a relatively late date was the flood plain of the Nile and its delta extension, constituting the Egypt of history, formed within the trough with a northward fall of about six inches to a mile. The partial dissection of the marginal fans, on which the flood plain overlaps, is thought to have been prompted by the removal of the fan fronts by lateral river erosion. The delay in the arrival of the Nile is attributed to the total loss of its waters by evaporation in the initially much larger Sudd, where an enormous volume of local rainfall and river inflow is lost even today, but where enough now survives to maintain an overflow northward.

W. M. Davis

The Ancient Topography of the Faiyûm and the Problem of Lake Moeris. The most recent attempt to solve the problems raised by the accounts given by Herodotus and other ancient writers of Lake Moeris in the Faiyûm district of Egypt has been made by Georges Hug in "Le 'Moeris': Étude de géographie physique historique" (*Bull. Soc. Royale de Géogr. d'Égypte*, Vol. 15, 1927, pp. 1–44). His solution is based upon a personal study of the geology and topography of the Faiyûm and is an interpretation of the results of his observations in the light of generally accepted principles of shore-line development.

In general M. Hug's conclusions as to the history of the Faiyûm lake differ little from those set forth by the reviewer in the *Geographical Review* for July, 1926 (pp. 353 ff.) on the basis of the works of Brown, Beadnell, and others. In one point,

however, there is a substantial conflict, namely in the level assigned to the historic Moeris and, consequently, its use as a artificial reservoir. Hug believes that the lake never stood for any length of time at a high level of 22 or 23 meters, with a low level of 17.5 meters, and holds that its southern beach, traceable in a sandy bar running from east to west across the province, indicates a high level of 18 and a low level of 16 meters. What Major Brown interpreted as an artificial dike constructed to hold a flood level of 22 meters in the lake, Hug shows to be a natural barrier beach, with an elevation of from 22 to 24 meters in its eastern and only 20 meters in its western part, produced during a period of temporary equilibrium between the water supply derived from the Nile and the process of evaporation. The colossi at Biahmu mentioned by Herodotus were erected under the Twelfth Dynasty subsequent to the formation of this barrier. Hence it seems logical to conclude that the lake had by that time sunk to the shore line of 18 meters. This level, the author thinks, is that of the Lake Moeris of Herodotus. If so, its level would be too low for it to serve as a reservoir with an outlet through the Bahr Yûsef gap. However, here one should take into account not the present level of El Lahûn, as Hug does, but the 18-meter rock barrier in the Bahr Yûsef.

The one serious difficulty with this theory is how to explain the maintenance of the 18-meter level from the nineteenth century to the fifth century before the Christian era when Herodotus visited Egypt. For in the course of the next two centuries the lake had sunk to sea level or below. The suggestion that Herodotus meant to say that the colossi stood "in the middle of the lake shore" instead of "in the middle of the lake" seems less plausible than that the historian saw them during flood time with an irrigation basin in front and the lake behind. Nor does Hug's view that the tradition of Lake Moeris as a reservoir is a dim remembrance of the prehistoric lake with its higher water level commend itself. It is much simpler to suppose regulators at Lahûn and Hawâra which closed the Bahr Yûsef when the arable land in the Faiyûm had been flooded and diverted the water from this canal into one leading north into the valley.

In a supplementary note Hug rejects, rightly I think, the theory of Petrie (*Journ. Royal Anthropol. Inst.*, Vol. 56, 1926, pp. 325–327), that Lake Moeris attained its maximum level (26 m.) in Ptolemaic times, and that of Miss E. W. Gardiner (*ibid.*, pp. 301–323), that there were two distinct lakes, the one prehistoric at a level of 23 meters and the other the historic Moeris which rose to 18 meters and then gradually subsided. Hug finds support for his own views in the careful topographical observations of Miss Gardiner on the northern side of the Birket Qarûn.

In "The Recent Geology of the Northern Fayum Desert" (*Geol. Mag.*, Vol. 64, 1927, pp. 386–410) Miss E. W. Gardiner gives a detailed report of her investigations into the question of the Faiyûm lake. On the basis of a careful examination of the most recent deposits—the lake beds—she reaches the following conclusions. Within Pleistocene times at least four distinct high lake levels are traceable. These are: (1) at 97–112 feet (over 30 meters) above sea level, not previously recorded and probably the earliest; (2) a 74-foot (23 m.) level which gradually sank until the lake to which it belonged completely, or very nearly, dried up; (3) a level of 57 feet (17.4 m.) belonging to a lake which appeared after the deposits of (2) had been hardened and eroded. When this lake in turn had begun to subside its shores were peopled by Neolithic flint users who certainly antedate the XIIth Dynasty; (4), a 12-foot (4.7 m.) level, representing a new lake, or a revival of the Neolithic lake belonging to the historic period. In conclusion, Miss Gardiner discusses Georges Hug's "*Le Moeris*," signaling the points of agreement and disagreement between them and answering his criticisms. In particular she defends the prehistoric 74-foot lake, while agreeing that there was no historic lake at that level and that the supposed dike is a natural geological formation. Her opinion that the problem of the relationship of these several lakes, their age and duration, and their connection with climatic

changes in other regions cannot be settled until the whole basin has been studied more adequately seems thoroughly sound.

A. E. R. Boak

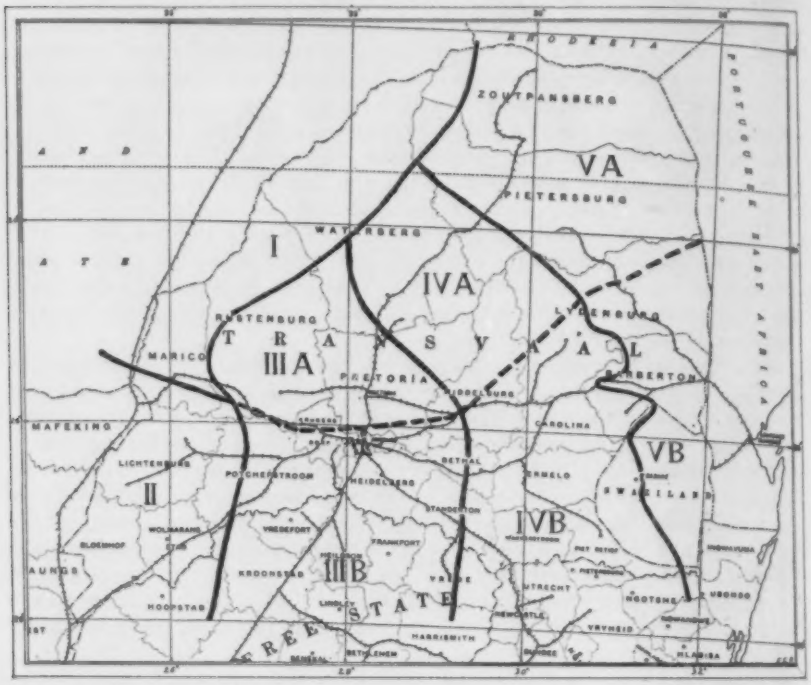


Fig. 1—Hyetal regions of the Transvaal. Reproduced from Map 17 of "Rainfall and Farming in the Transvaal." Scale approximately 1:8,500,000.

Agricultural Regions of the Transvaal. "The production from farming in South Africa is predominantly a moisture limited one" is the text of "Rainfall and Farming in the Transvaal" (*Transvaal Univ. College Bull. No. 12*, Pretoria, 1927). In Part I Professor F. E. Plummer gives the result of "A Preliminary Investigation into the Variability of the Rainfall in the Transvaal" (see also *South African Geogr. Journ.*, Vol. 9, 1926, pp. 5–20). His analysis is directed towards an appraisal of rainfall efficiency. Thus it is based on the hyetal year starting July 1, because 80 to 92 per cent of the annual rainfall occurs in the summer months, October to March. The general mean value of rainfall is relatively high, nearly 29 inches, but its "adequacy for agriculture is disappointing." As yet data for analysis are meager, and arithmetical means are inadequate where the rainfall approaches critical limits; years of abnormally high rainfall for instance exert an undue influence on the figure for the average. Professor Plummer considers the "most probable" means by the method of least squares. A series of maps illustrates his analysis and concludes with one of the "Hyetal Regions of the Transvaal," reproduced herewith. In broad outline it constitutes a land utilization map. A brief description of this map is given in Part II, "Rainfall in Relation to Agriculture in the Transvaal," by Professor H. D. Leppan.

Region I with low rainfall (20 inches), high evaporation coefficient, and extreme unreliability is a pastoral region of a ranching type. Though Region II has a still smaller rainfall, evaporation is lower, the land higher, and run-off smaller, and farming

possibilities are better. The region is adapted to sheep as well as cattle. The agricultural economy of both Regions I and II will lie in the main in the breeding of animals to be fattened in regions of more assured fodder crops. Region III A with more rainfall is transitional in character. Maize and sorghum are successful most years on the better soils. Peanuts and cotton may be grown on rainfall alone; and tobacco, alfalfa, winter cereals, citrus fruits under irrigation. Proximity to mining and industrial regions will encourage diversified farming but the variation of the rainfall means a measure of instability. This disability has less weight in Region III B where the possibilities of diversified farming and high production over a large area are "scarcely paralleled anywhere else in South Africa." The length of the frost-free period, however, does not permit the cultivation of cotton and other subtropical crops.

Region IV A is a transition region like III A. Rain reliability is greater, but rugged topography encourages pastoral occupation. Region IV B enjoys the most effective rainfall of the Transvaal, but the smaller amount of sunshine from the center towards the east is less favorable to maize; on the other hand cool conditions in the higher portions permit the growth of oats and turnips.

Region V A exhibits wide differences in altitude and climate, but rainfall is generally unreliable. Except where irrigation is possible or the rainfall is over 35 inches arable farming must be attended by a large measure of uncertainty. The region includes much undeveloped land, which is offered at low prices. Professor Leppan points out that this unfortunately is likely to attract those least able to support the financial strain imposed by the erratic rainfall. Region V B is similar though less unreliable and possesses better possibilities of irrigation.

Water Supply Problems of Kenya Colony. Though Kenya Colony lies on the equator, much of it is poorly watered. Mr. A. D. Lewis, Director of Irrigation of the Union of South Africa, who has recently made an investigation into the water resources on behalf of the government of the colony, estimates that no less than 42 per cent of Kenya has less than 20 inches annual rainfall (Colony and Protectorate of Kenya: Report on Irrigation, Water Supplies for Stock, Water Law, Etc., London, 1925). This northeastern half of the colony is an extension of the Somaliland desert. With the exception of a few tribes along the Tana, Athi (Sabaki), and Uaso Nyiro Rivers and a few water holes a huge stretch is almost uninhabited. In the most arid section, between the Uaso Nyiro and the northeastern frontier, are certain features, wells, pits, cairns, and pools, that have been interpreted as the water engineering works of an ancient and numerous population when the country was more suitable for occupation (C. B. G. Watson: Wells, Cairns, and Rainpools in Kenya Colony, *Man*, March, 1927, pp. 50–52). From this point of view the region merits further study. Of more immediate practical importance, however, is the problem of that section of the colony having a rainfall of between 20 and 30 inches and comprising 30 per cent of the area. It includes the bulk of the Masai Reserve, parts of the Ukamba Reserve, and small European areas (see the map "The Colony and Protectorate of Kenya," by L. Carpenter, Statistical Officer of the Dept. of Agriculture, Kenya, 1924–1925).

Mr. Lewis considers that the possibilities of extensive irrigation schemes in Kenya are "exceedingly poor." From the Tana, the only important stream, some 150,000 acres might be irrigated, but most of this would be in the lower course of the river where the primitive character of the population would not warrant the undertaking. From the Athi and its tributaries the irrigation of 15,000 acres might be possible, from the Uaso Nyiro, 5000 acres; and in the Rift Valley, where the need is urgent, 2000 acres. It is pointed out, however, that there are enormous areas in the colony where the rainfall is sufficient for the practice of ordinary agriculture if care be taken to conserve soil moisture. Special attention is called to sisal production where water require-

ments are small. Sisal is grown successfully with a rainfall of under 30 inches while the water required for factory purposes for "2000 acres of sisal would barely suffice for the irrigation of 20 acres of ordinary crops."

On the other hand there appear to be reasonable prospects of increasing the water supply for stock requirements by boring over a large area. Connected with this is the administration's desire the better to control the nomadic tribes. The establishment of large water centers capable of maintaining 10,000 head of stock and equipped with schools and dairies has been suggested, but, as Mr. Lewis points out, there is grazing to be considered as well as water. Overgrazing would probably result, especially in times of drought. Then, if rains fell elsewhere the population would move away leaving the schools empty and the dairies unused and thus remain "almost as elusive as formerly in matters of control and supervision." He comes to the conclusion that initial experiments should be based on a herd not exceeding 500 head, a number that supports 25 persons on the average.

The Destruction of the Malagasy Forests. The seriousness of deforestation in Madagascar is the subject of a paper by Dr. H. Humbert, of the University of Algiers, who has lately been on a mission to the island (La disparition des forêts à Madagascar: Ses causes, ses conséquences, *Rev. Gén. des Sciences*, Vol. 37, 1927, pp. 325–336). The native cultivation, *tavy*, exploitation of the forest products by the whites, and prairie fires are the chief destructive agencies. The actual area of virgin forest remaining is not known; excluding the Euphorbia scrub forest of the arid south it may be estimated at between two million and three million hectares, between one-thirtieth and one-twentieth of the total area of the island. This forest is distinguished by its great variety of species, including many peculiar forms, and it does not reëstablish itself when once destroyed. Like Perrier de la Bâthie, the author of the important work "La végétation malgache" (discussed in the *Geogr. Rev.*, Vol. 12, 1922, pp. 496–498), Humbert makes a prime distinction between the autochtonous and the secondary vegetation, the latter distinguished by the small number of species and the frequent dominance of one or two forms.

In the more humid east the virgin forest is replaced by second-growth woodland, *savoka*. If periodic burning over is resorted to, the *savoka* passes over to prairie. In the regions with a pronounced dry season the passage from forest to grass is direct. The area of *savoka* is now greater than that of the virgin forest. Grassland, however, is the dominant formation, occupying about five-sixths of the island. On the central plateau, for instance, so few are the forest remnants that steppe was long considered the native vegetation, though this is disproved by the character of the surviving forest remnants and the floristic character of the grassland. Dr. Humbert urges a revision of methods of cultivation and exploitation and the immediate establishment of natural reservations as the only means of saving from complete extinction the island's unique flora and fauna, "the precious heritage of a long geological past." (See also his note "Sur la flore des Hautes-Montagnes de Madagascar" in the *Compte Rendu Sommaire des Séances de la Soc. de Biogéogr.*, No. 31, 1927.)

Methods of native cultivation broadly similar to this robber economy of Madagascar are known elsewhere, but an argument against universal condemnation of such ways on superficial appearances alone is advanced by Father Hyacinthe Vanderyst in a paper "Géo-botanique agronomique comparée: La destruction des forêts à Madagascar et leur non-destruction au Congo par les pratiques culturales indigènes" (*Congo et Bull. Soc. Belge d'Études Colon.*, Vol. 2, 1927, pp. 1–14). He stoutly maintains that the *masole* system of forest clearing, a cultivation practiced by the Congo natives, is not attended by evil consequences. Father Vanderyst has had twenty years' experience in the Kwango region, and he rightly points out the differences in the native vegetation of the two countries. He asserts that the Congo vegetation can for the most part reëstablish itself and says that destruction by bush fires is

unknown in the Congo. A contrary view, however, is expressed by É. de Wildeman, director of the Botanical Garden of Brussels, who refers to fire on the lower Congo as an agent in transforming the country "geo-botanically and orographically" and pleads for natural reservations in the Congo for the conservation of plants of scientific and economic interest (Considérations sur l'état actuel des connaissances relatives à la géo-botanique du Congo Belge, *Congo: Rev. Gén. de la Colonie Belge*, 6th year, 1925, Vol. 1, pp. 715–734; Vol. 2, pp. 13–36).

AUSTRALASIA AND OCEANIA

Early Maori Agriculture in New Zealand. Changes in their natural environment forced the Maori who settled in New Zealand to become a far more industrious people than they had ever been during their residence in Polynesia. Coming from semi-tropical islands where slight efforts at cultivation had resulted in large food returns, they found themselves in a country where a comparatively harsh climate forced them to devote most of their time to the collection of food. As the aborigines of New Zealand did not cultivate the soil, the Maori, although essentially an agricultural people, were forced to exist for a while on a scale of culture lower than that to which they had attained before their immigration. Hunting and fishing furnished important means of livelihood; and the fern root, a food plant new to the Maori, became of such consequence that a myth grew up regarding its origin. Attempts to introduce domesticated plants from the Polynesian Islands were only partially successful. By increasing their efforts the Maori were able to raise some of their more important foods in favorable locations. A system of barter grew up between the agricultural districts and those regions where hunting and fishing still supplied the principal means of sustenance.

The Maori settlers of New Zealand took many precautions in growing the *kumara*, or sweet potato—the most important of their cultivated plants. They selected sheltered spots, heaped fine gravel about each plant to insure perfect drainage, constructed fences and windbreaks, and provided fertilizer in the form of wood ashes. Cultivation was generally accomplished by a *ko*, merely a sharpened stick with a rudely constructed crossbar. Agriculture was regarded as a communal affair, participated in by all the people and accompanied by much ceremony. Considerable time and labor must have been expended on the well-kept plantations which have been described by Captain Cook and subsequent voyagers. In "Maori Agriculture" (*New Zealand Dominion Museum Bull. No. 9*, Wellington, 1925) Elsdon Best has compiled a quantity of material on "The Cultivated Food Plants of the Natives of New Zealand, with some Account of Native Methods of Agriculture, its Ritual and Origin Myths."

HISTORICAL GEOGRAPHY AND HISTORY OF GEOGRAPHY

Geography of the Odyssey. Where lay the islands and coasts which Odysseus visited? Among the German scholars who have been trying of late to answer this perplexing question some would restrict the Odyssean wanderings to the Mediterranean; others would carry them far out into the Atlantic. In the first group belongs Albert Herrmann, whose paper on Homeric geography was discussed in the *Geographical Review*, Vol. 16, 1926, pp. 670–671. The second group is represented, among others, by Adolf Schulten (see his "Tartessos," 1922) and by Richard Hennig, both of whom maintain that through contacts with the Phoenicians the Hellenes of the Homeric age acquired knowledge of the western ocean and that this knowledge was reflected in the epos.

In a volume entitled "Von rätselhaften Ländern," Munich, 1925, and in subsequent papers Hennig discusses various phases of the problem ("Das Weltbild Hom-

ers," *Zeiten und Völker*, Vol. 22, 1926, pp. 274–278; "Neue Betrachtungen zur Geographie Homers," *Geogr. Zeitschr.*, Vol. 32, 1926, pp. 290–296; "Grundsätzliche Bemerkungen zur 'Geographie Homers'," *ibid.*, Vol. 33, 1927, pp. 22–34; "Die Frage des Lästrygonen- und Kimmerierlandes," *Petermanns Mitt.*, Vol. 72, 1926, pp. 164–166.) He points out that many students of Homeric geography through exclusive preoccupation with philological and archeological evidence have acquired what he believes to be an absurdly limited view of the range of Homeric knowledge, particularly towards the west. To these scholars the western Mediterranean—even Italy and Sicily—lay on the edges of the known world of Homer's time. The opposite extreme of opinion is represented by one over ingenious but uncritical writer, who goes so far as to suggest that Odysseus actually entered the north polar regions; or by another enthusiast who argues that the wanderers reached the southernmost tip of Africa. As compared with these flights, Hennig's own interpretation of Odysseus' route is conservative, even though it might seem radical to the more old-fashioned classicists. He identifies the Cimmerians with the Kymri of Cornwall, placing the entrance to Hades in their country. He locates Scheria, or the land of the Phaeacians, at Tartessus in southwestern Spain and the Island of Ogygia in the Canaries.

Ogygia was the Island of Calypso, daughter of Atlas, "who knows the depths of every sea, and himself upholds the tall pillars which keep earth and sky asunder." (Odyssey, I, 53–54; S. H. Butcher and A. Lang's transl., p. 3). These pillars of Atlas have almost universally been associated with the Pillars of Hercules on either side of the Strait of Gibraltar. Hennig believes it more reasonable to identify them with the far more impressive Peak of Teneriffe. Indeed, the term "Pillars of Hercules," he maintains, did not come to signify the mountains of Calpe and Abyla overlooking the strait until as late as the fifth century, when the strait was closed by the Carthaginians (see Hennig's "Zum Verständnis des Begriffs 'Säulen' in der antiken Geographie," *Petermanns Mitt.*, Vol. 73, 1927, pp. 80–87. See also, however, Adolf Schulten, "Die Säulen des Herakles," in O. Jessen's "Die Strasse von Gibraltar," Berlin, 1927, pp. 174–206, especially p. 176, note 4; *Geogr. Rev.*, Vol. 17, 1927, pp. 505–506.) The lands of the Lotus Eaters, Cyclopes, and Laestrygons Hennig places on the coasts of the Mediterranean in what are now Libya and Tunisia.

Of the land of the cannibal Laestrygons Homer said: "There might a sleepless man have earned a double wage, the one as a neatherd, the other shepherding white flocks: so near are the outgoings [κέλευθοι] of night and day" (Odyssey, X, 83–86; Butcher and Lang's transl., p. 156). This passage has given rise to theories which have interpreted the κέλευθοι (usually translated as "paths") of night and day as referring in some way to the relations of day to night at high latitudes. Hennig believes that κέλευθοι means, rather, "pastures" and that the passage as a whole is more probably an echo of travelers' reports describing African peoples, such as those mentioned by Varro, who pasture sheep by day and neat cattle by night in order that the latter may avoid the tsetse fly.

In view of the vagueness of the Odyssey itself and the fragmentary character of our historical knowledge of the Homeric period, these problems, like that of Atlantis, are hardly as yet susceptible of definite settlement. The attempts that are being made to interpret the poems in the light of their cultural and geographical environment, however, are not without popular interest and scientific value.

Medieval Transportation and Travel. In the October, 1926, number of the periodical of the recently organized Mediaeval Academy of America published at Cambridge, Mass., Professor J. F. Willard contributes a short, scholarly article on "Inland Transportation in England During the Fourteenth Century" (*Speculum: A Journal of Mediaeval Studies*, Vol. 1, pp. 361–374). This subject was neglected by J. J. Jusserand in his "English Wayfaring Life in the Middle Ages" (London, 1889; N. Y., 1920) in so far as the "transportation of goods by land and water" is

concerned. It seems that carts were used more than pack animals in the fourteenth century. Some idea of the speed of cart travel may be derived from these data: "two carts with victuals for the army made the journey from Malmsbury, in Wiltshire, to Carlisle in twelve days. . . . It took a cart with five horses eight days to go from Gloucester to London and return"; the journey from Lincoln to the Tower of London was made in nine days, as was that from Westminster to York. Pack horses were employed for light local transport, as well as "at or near the seacoast for the carriage of fish" and "to carry treasure or money across country in baskets or packs." Professor Willard's general conclusion is that "the roads of the fourteenth century were not quite so bad as they are often pictured, and that heavy carts moved over them at a reasonable speed. What is more, the transportation of goods was to a high degree free from danger. On every stream of fair size there were boats; on every road there were carts and pack-horses. The most vivid impression is that of the large amount of movement along the roads and streams, and with it the lack of isolation of mediaeval towns and villages."

In the same number of *Speculum* (pp. 375–397) Professor A. S. Cook discusses what little is known of the details of the famous journey of Augustine to England in 596—in its time a long and arduous undertaking. Professor Cook's article brings together incidentally not a little interesting material on land and water travel in the early Middle Ages.

Publication of the La Vérendrye Documents. In a note which appeared in the *Geographical Review*, Vol. 6, 1918, pp. 283–284, attention was called to the sensational finding at Pierre, S. Dak., in 1913 of "a lead plate deposited in 1743 by the sons of the intrepid explorer, the Sieur de Verendrye." In the same note the search by the La Vérendryes for the "Western Sea" and their possible discovery of the Rocky Mountains were discussed. During the last year, as one of the excellent *Publications of the Champlain Society*, Lawrence J. Burpee has edited, with English translations, notes, and an introduction, the *Journals and Letters of Pierre Gaultier de Varennes de la Vérendrye and his Sons: With Correspondence Between the Governors of Canada and the French Court, Touching the Search for the Western Sea* (Toronto, 1927). Mr. Burpee offers no new evidence in regard to the route of the younger La Vérendryes. After explaining various theories that have been put forward, he reaches the following conclusion: "On the whole, it would seem that the best case is made out" by Doane Robinson, who contends that the mountains sighted were the Black Hills rather than the main range of the Rockies—though this view "leaves the exploration of no very striking importance."

Such a judgment, relating only to the particular expedition of 1742–1743, should not blind us against recognizing the importance of the explorations of the La Vérendryes, as a whole. To them still belongs the major credit for opening up vast regions west and northwest of Lake Superior. They were undoubtedly the first white men to see the waters of Lakes Winnipegosis and Manitoba, to follow up the Saskatchewan River as far as its forks, and to visit the settlements of the interesting non-nomadic Indians of the Missouri, whether or not these were the Mandans. It is also probable that the senior La Vérendrye was the discoverer of Lake Winnipeg. His place, with that of his sons, in the history of the exploration of the heart of North America is secure.

OBITUARY

David George Hogarth. In the premature death of Dr. D. G. Hogarth at Oxford on November 6, 1927, in his 66th year, science has suffered a grievous and irreparable loss. At a time when Great Britain never was in sorer need of statesmanlike scientists with vision and administrative ability, there was no man in the whole range of archeological activity who could so ill be spared. While the loss to

science is severe, the loss to his friends is even more grievous. In a long experience with men of his type, I have never met another who combined in so high a degree scientific ability and personal charm.

Hogarth possessed the confidence of the British Government, and I might say of all governments having anything to do with the Near East, to an extent perhaps unequaled by any other scientific man and certainly by no other man of science at work in the Near East. It is not generally known that one of Hogarth's greatest services to science was lost to the world through the dilatoriness of the Lloyd-George régime in dealing with the Turks after the triumph of the allies, a policy which was as costly to science in the territory of the former Ottoman Empire as it has also been in Egypt. A group of American archeologists, among whom the lamented Howard Crosby Butler was prominent, drew up a set of conditions which for the first time in history would have ensured to science the right to carry on scientific investigation throughout the territory of the former Ottoman Empire. When these conditions were placed before the Peace Commissioners assembled in Paris, it was the influence of Hogarth, officially representing Great Britain, which had more to do with convincing the Commissioners of the wisdom of the proposed provisions than that of any other representative. The stipulations were incorporated in the Treaty of Sèvres, but they were unhappily not carried over into the Treaty of Lausanne. It was in such situations that a scholar-statesman like Hogarth was able to render services of incalculable value to science.

Among his many admirable qualities the wide scope of his outlook is most conspicuous. Born and bred in a country parsonage, he always carried with him, whether at school in Winchester or afterward at Oxford, those fine traditions of an English clergyman's home that have given to the British Empire so many men of achievement. During a brilliant career as an undergraduate at Oxford he did not specialize in the lines of study in which he later gained distinction. At the age of thirty-one, however, he was appointed a "Research Fellow" with opportunities of travel in the lands of the Near East. Then began his highly varied activities in these regions. As Director of the British School of Archeology at Athens and Director of the Cretan Exploration Fund he rapidly made his place as a great British archeologist. For twenty years he was tireless in his explorations, especially at Ephesus in Asia Minor, at Carchemish in Syria, in Cyprus, in Egypt, and in Arabia. He was greatly interested in the Hittites, made himself master of the archeological problems in this field, and applied his mind with great penetration to disengaging the various subvarieties and differing cultural areas that had hitherto borne the name Hittite without proper differentiation.

The writer recalls among the pleasantest memories of his life the privilege of receiving Hogarth as a guest when the great archeologist was lecturing in America for the last time. A lecturer of singular charm, his addresses on the civilization of the Hittites drew large audiences. He was equally attractive as a writer; and many a reader who might never have known the delights of archeological and geographical explorations has made their acquaintance in Hogarth's beguiling volume, "A Wandering Scholar in the Levant." He turned aside from such studies long enough to write a life of Alexander and his father, Philip of Macedon; but it was exploration that especially attracted him, and although he never equipped himself as an Orientalist or an Arabist, philologically speaking, he was deeply interested in Arabia. His Arabian studies are among his most useful books.

With Hogarth archeology and exploration were always inseparable, and with his wide knowledge of the ancient classical sources he gradually became a geographer. He made his first visit to the Near East in 1887, in company with Sir William Ramsay, and wandered through Asia Minor with that great scholar. In the intimate details of local topography his contributions to geography have been most valuable; while his breadth of view appears characteristically in that excellent regional study

"The Nearer East." In 1917 the Royal Geographical Society awarded him their Founder's Medal, one of the highest distinctions within the reach of a geographer, and in 1925 he was elected President of the Royal Geographical Society. His third term had just begun, and he was about to preside at the first of its winter sessions when the end came.

Hogarth's wide knowledge of the Near East naturally made him of great value to his country during the war, and he was the obvious selection when the Government was looking about for a director of the Arab Bureau at Cairo. It was under Hogarth also that Lawrence, one of the most valuable servants of the British Government in the Near East during the Great War, received his training, especially during Hogarth's excavations at ancient Carchemish, on the fringes of the Syrian Desert, where Lawrence met many Arabs.

Not the least of Hogarth's services has been his administration of the Ashmolean Museum at Oxford, where he had been Director for nearly twenty years since the retirement of Sir Arthur Evans in 1908. This important post he was still occupying at the time of his death, and here his loss will be immediately and more directly felt; but his many-sided interests, his fine judgment, and his statesmanlike vision will be sorely missed throughout the whole range of scientific research in the Near East.

JAMES H. BREASTED

GEOGRAPHICAL REVIEWS

An Analysis of Early European Colonization in America

Georg Friederici. **Der Charakter der Entdeckung und Eroberung Amerikas durch die Europäer: Einleitung zur Geschichte der Besiedlung Amerikas durch die Völker der Alten Welt.** Vol. 1, xiii and 579 pp. (Allgemeine Staatengeschichte: Geschichte der Aussereuropäischen Staaten.) Friedrich Andreas Perthes, Stuttgart-Gotha, 1925. 9 x 6 inches.

Friederici's volume is a product of German scholarship at its best. The love for detail, the boundless curiosity regarding facts, the passion for following every subject into all of its ramifications are here happily combined with a lucid style and with skill in marshaling details to illustrate original ideas. As the title implies, the book is not a narrative history but an analysis and comparison of conditions and movements.

The volume is divided into three parts. In the first "the scenes of colonization" (die Kolonisationsschauplätze) and in the second the aboriginal inhabitants are discussed, these two parts covering the whole of America. The third part is devoted to the Spanish explorers and conquerers. Presumably the colonization of the present territory of the United States and Canada will be made the subject of a future volume or volumes.

In treating the scenes of colonization the author endeavors to reconstruct not only the natural environment as it existed during the great Age of Discovery but also the means of transportation and communication developed by the Indians at the time of the arrival of the Europeans. Innumerable passages and stray remarks in the writings of soldiers, travelers, and historians are correlated with the results of modern scientific research. The ways in which the differing environmental circumstances from region to region helped or hindered the progress of exploration, conquest, and settlement are suggested and compared. For example, Friederici finds an explanation of the very divergent histories of the Guianas and Venezuela in divergent geographical conditions. Although in climate and position these two regions have much in common, the shore line of the Guianas consists of a low alluvial plain whereas that of Venezuela is fringed by mountains. "While Venezuela invited colonization through its many superb harbors and its fruitful coastal fringe, Guiana's alluvial mangrove-covered shore repelled it. The latter was neglected by the Spaniards, who had at their disposal so much better land, and at an early date fell into the hands of their rivals, the Dutch and French, and later the English."

Friederici lays a great deal of stress on the part played by the Indians in facilitating the advance of the white man. Indian trails offered routes through forest, brush, and desert; Indian bridges spanned many a stream. A magnificent network of roads bound together the empire of the Incas. In regard to bridge building, the aborigines of America were far in advance of the primitive "Indo-Germanic" folk. "On a march of only about 170 kilometers from Orsza to Smolensk, King Sigismund I of Poland [1506–1548] was obliged to throw 340 bridges across swamps, ponds, and brooks. How different was the experience of De Soto in the territory of the present United States!" The geographical knowledge and sense of direction possessed by the Indians were also frequently of service to the early travelers. Friederici devotes no less than six pages to a discussion of Indian maps, citing cases where such maps are known to have been used by explorers.

The third part of the volume is itself divided into three chapters. Of these the first, devoted to the character of the discovery and "unveiling" (Entschleierung) of

the coasts of America by the Spaniards, is a truly masterful analysis of the historical, geographical, and nautical background of Spanish marine exploration. Friederici speaks of the superlative greatness of Columbus as manifested not only in the first voyage but in the three that followed. Each "marked an epoch, each determined the general direction that subsequent exploring expeditions were destined to pursue for years to come." In the *expediciones á descubrir* sent out by the Casa de Contratación the author sees predecessors of the maritime scientific expeditions of the late eighteenth century, arguing, hence, that Oscar Peschel is unjustified in claiming that Dampier's voyage of 1699 was the first undertaking of this sort. The Spaniards, indeed, would seem to have been far in advance of their contemporaries in the matter of organized scientific exploration. In the final chapter of Part III, on the technique of the "Conquista," it is explained that "the very first thing that the Spaniards undertook to do in a hitherto unknown country was to carry out a thoroughly businesslike and far-reaching examination of the entire region in order to learn . . . the *secretos de la tierra*," these, of course, being primarily "precious metals, precious stones, pearls, and buried treasure in temples and graves." Strict governmental regulations controlled the gathering and compilation of the data, which thereby acquired a high scientific value and were ultimately made available to the "cosmographers and chroniclers of the Crown."

We await eagerly the subsequent volumes of Friederici's stimulating work. The work as a whole certainly ought to be translated into English.

Reflections of the Prairie in Literature

D. A. Dondore. **The Prairie and the Making of Middle America: Four Centuries of Description.** xiii and 472 pp.; ills., bibliogr., index. The Torch Press, Cedar Rapids, Iowa, 1926. $4.50. 8½ x 6 inches.

"Professor Turner and his followers have demonstrated convincingly to us the significance of the Frontier in American history; its influence on literature has never been determined." Thus Miss Donore suggests her purpose. The present volume is the first of a series in which she plans to consider the influence upon literature not only of the prairie but of the "Forest, . . . the Plains, the Mountains, and the Sea."

The Mississippi Valley has been the source of an immense and varied outflow of expression in print since the days when Cabeza de Vaca "first wrote an account of the bison and the great plains, . . . first crossed the continent from coast to coast." Down the whole course of this vast literary river, the varying currents and eddies of which Miss Donore surveys, two broad tendencies have been evident: that of the realists and that of the more imaginative writers who see the prairie through a purple haze of romance. As between these two groups form is not necessarily the determining factor. The realists, particularly those of the nineteenth and twentieth centuries, have often chosen the novel or poem rather than the more sober book of travel as their artistic medium.

To the French and Spaniards of the seventeenth and eighteenth centuries Miss Donore ascribes the "establishment of the romantic tradition" of the prairie. "The great inland valley that they discovered and explored was a world with the freshness of the dawn upon it, dewy sweet, exceptionally fertile, its bison-pasturing meadows, its dense forests, its placid waterways offering an idyllic background, fascinating vistas for adventure." This concept was taken over by later Anglo-Saxon romanticists and was carried even beyond the limits of the English tongue. "Probably not one of the literatures of Europe was left untouched by the influence of the new continent." "The advance line of civilization, moving across America as it moved across the fens and forests of the old world, for a couple of centuries lodged in the Mississippi Valley. And in turn the Valley's most distinctive features, the Prairies,

together with the forests and rivers and the life they produced formed a distinct thread in the romantic literature of America and Europe. They with the rest of the frontier created a new and rich storehouse of materials for literary interpretation."

The prairie was preëminently the home of that fanciful creation of the philosophers of the *ancien régime* in France, the noble savage, whose virtue so eminently excelled that of the effete and corrupt European (see *Geogr. Rev.*, Vol. 16, 1926, pp. 671–672). But when it grew all to obvious that many of the Indians with whom the French actually came into contact had suffered terribly as a result of "the smallpox and strong drink" which these contacts had brought to them and were "living as down-at-the-heel neighbors of the whites . . . nothing was easier than to transfer to the Creoles the idyllic traits that had been in the making since the era of discovery; the cult of the native had become the cult of the habitant."

Miss Donore, discussing the development of romantic and realistic treatments in separate chapters, carries her survey down to contemporary times, long after the frontier had passed across and beyond the prairie. She even takes into consideration the city life of the Middle West, more particularly that of Chicago, as it figures in literature. Her book is a welcome contribution not only to the literary history but to historical geography, inasmuch as it traces the development of relations that have existed between a distinctive geographical region and one of the most important of all of the activities of the human mind (see also *Geogr. Rev.*, Vol. 14, 1924, pp. 659–660).

Fifty Years of Change in New England

D. C. Brewer. **The Conquest of New England by the Immigrant.** vi and 369 pp. G. P. Putnam's Sons, New York and London, 1926. $2.00. 7½ x 5½ inches.

This story of Mr. Brewer's is not a new one. His contribution is largely in the forceful marshaling of the facts and in the trenchant manner of presenting them. The argument is well outlined in the headings of the five parts of the book: New England As It Was and Is; The Making of the Yankee; Expansion and Deterioration; Invasion; and Conquest.

The indictment against New England is severe. To use the author's phrase the New Englander is accused of scuttling the craft which carried their promising fortunes—not the original founders of New England but the sons of the first manufacturers who with a desire for wealth enlarged the village mills many fold and to man them became the advocates and instruments of easy and unrestricted immigration. The resultant in figures is fairly well known and after a fashion appreciated; at the same time it is an appalling condition. Smith in his "North America" states that one can hear every language save English on Boston Common; that a visitor at the City Hall in Woonsocket, R. I., heard no English except what was addressed to him; and Brewer adds to these hyperboles another—"unless we bid farewell to the new Boston, . . . we shall need an interpreter to get us out of the Hub."

Mr. Brewer would be the last man to place the entire blame for the present plight of New England on New Englanders alone. His earlier book, "The Perils of the Republic," shows him to be a deep student of the immigration question as it affects the entire country. The book under review, then, is only a section of his charge against the country as a whole for its immigration policy. The manufacturing elements have been the benefactors of open immigration at the expense of other industries and other occupations; and in this New England, especially southern New England, has had a large part.

But although the manufacturer benefited by opening the doors to the people of Europe, the country as a whole was not hostile to this plan, and there was a rather general agreement among nearly all classes to it. It was the age of the "melting

pot" idea. This dream, now generally admitted to have been on the wholesale plan at least a mistake, was a potent argument for immigration.

With restricted immigration possibly some of the forebodings of this book may not be realized, and possibly New England may regain her former culture. Then, again, one must wonder what New England's destiny under the former régime was. Her soil was inhospitable and her sons were peopling the West. Even today her manufacturing supremacy is contested. But whether or not New Englanders accept the flagellations of Mr. Brewer, it will do them a world of good to read and ponder upon this presentation.

ROBERT M. BROWN

PIONEER COMMUNICATIONS IN THE AMERICAN WEST

L. R. HAFEN. **The Overland Mail, 1849-1869: Promoter of Settlement, Precursor of Railroads.** 361 pp.; map, ills., bibliogr., index. The Arthur H. Clark Company, Cleveland, 1926. $6.00. 9½ x 6½ inches.

Dr. Hafen has given us primarily an historical account of the development and expansion of the overland mail in the Trans-Mississippi country. The geographer, however, can glean much of interest in regard to the layout of the various routes, the effects of various environmental obstacles, the importance of minerals and other natural resources, and the like.

As a background to the main topic of the overland mail there is given a résumé of the postal service and routes during Colonial times in the east and a discussion of the development of the ocean mail routes to the Pacific coast by way of Central America (1848–58). Routes were established at the three most feasible constrictions in Middle America: first across the Isthmus at Panama, then a rival route across at Nicaragua, and finally by the Gadsden Treaty a route across at Tehuantepec (1853). The early development of these sea routes to California is evidence that an overland mail, though shorter, had many more natural obstacles to overcome.

The earliest overland mail carriers in the Trans-Mississippi region were almost invariably either military couriers or private stages and express lines. The first regular mail contract was from Independence, Mo., to the Salt Lake "oasis," following the line of the Oregon Trail up the Platte and over South Pass. A complementary route was early established from California to Utah. For all practical purposes these two came to be a through route. In summer it was a short and very feasible route; but in winter snows seriously impeded travel across the Rockies, and heavier snows often suspended travel across the Sierra Nevada passes. This climatic factor as well as political interests directed the next expansion of the overland mail routes farther to the south. Lines were extended from Independence to Santa Fe and from San Antonio to Santa Fe. This movement culminated in the establishment of the famous Butterfield Overland Mail, which, until the outbreak of the Civil War, rendered superior service at all seasons, the stages making the through trip to California by way of Yuma in 20 to 23 days. There also was a line established somewhat farther to the north from Kansas City to Stockton, which however was rather unsuccessful. Following this period of rather rapid expansion a policy of retrenchment was put into effect by an administration which frowned upon the policy of the Post Office Department as a pioneering agency (1859–60). Service was cut down on all lines except the Butterfield route in an attempt to put the business on a paying basis.

The author seems to know his ground especially well when treating of the development of express and mail routes to the Pikes Peak region, across that great triangle of territory lying between the old Santa Fe and Oregon trails and the Rockies of Colorado. Gold drew people to this region, mining towns sprang up in and near the mountains, for which Denver City became the supply center. The crying need for

transportation with the outside world resulted in the establishment of the Leavenworth and Pike's Peak Express, a highly successful private enterprise.

Undoubtedly the most picturesque incident of the whole history of the overland mail was another private enterprise, the Pony Express. The fast and efficient riders demonstrated that the short central route was feasible and that obstacles could be overcome. The Pony Express was essentially supplementary to the rapidly expanding transcontinental telegraph line, gradually becoming shorter and shorter until the completion of the latter in 1861. When first established the advertised time by letter and wire from San Francisco to New York was nine days. The culminating phase of the overland mail was the establishment of a daily stage service over the central route, the "Million Dollar Mail" (1861–62). The development of other tributary routes went on apace, including lines to Denver and to the mining settlements in Montana in the Three Forks region. The inauguration of the transcontinental railroad over the central route brought about the gradual abolishment of the main stage line.

The book is a scholarly piece of research, and the flavor of the West has not been entirely buried beneath statistics. A geographer might well feel that the various descriptions of routes should be accompanied by sectional maps on a scale larger than the one folding map. The book is logically and simply organized, and the thesis is carried through, namely, that the overland mail, following in the wake of the first settlers, was in turn a promoter of settlement and a forerunner of the railroad. At least the book will prove a good antidote to geographic determinism.

ERIC P. JACKSON

PHYSICAL AND GENERAL DESCRIPTIONS OF ICELAND

THORVALDUR THORODDSEN. **Die Geschichte der isländischen Vulkane (nach einem hinterlassenen Manuskript).** 458 pp.; maps, ills. *Mémoires Acad. Royale des Sci. et des Lettres de Danemark, Sect. des Sci.*, Ser. 8, Vol. 9, Copenhagen, 1925.

ADRIAN MOHR. **Was ich in Island sah: Plaudereien vom Polarkreis.** 238 pp.; map, diagrs., ills. Otto Uhlmann, Berlin, 1925. 10 M. 9½ x 7 inches.

HEINRICH ERKES: **Neue geographische Forschungen auf Island.** Maps. *Mitt. Vereins für Erdkunde zu Dresden*, Vol. 3, 1925, No. 5–6, pp. 3–53.

THORSTEINN THORSTEINSSON, edit. **Iceland: A Handbook Published on the Fortieth Anniversary of the Landsbanki Íslands (National Bank of Iceland).** 184 pp.; ills., bibliogr., index. Prentsmidjan Gutenberg, Reykjavík, 1926. 8 x 5 inches.

In 1882, at the time when he was beginning the explorations of his native land, Dr. Thoroddsen issued in Danish a volume of some 170 pages, containing a historical survey of the Icelandic volcanoes; this was later translated, in a condensed form, into English by George H. Boehmer and published in the Smithsonian Report for 1885. During the intervening years between the appearance of that survey and the writing of this history of the Icelandic volcanoes here under review, the author had opportunity not only to discover new written sources in various libraries and archives but also to travel all over the country and thus to verify, on the spot, so far as that was possible, the numerous accounts of early volcanic eruptions and make his own observations of the various volcanic phenomena. It is a most thorough and scholarly work that he has given us. The author finished it in 1912 and, although he lived for nine years more, did not add anything to the manuscript, which is printed here as it was left by him; thus there are not mentioned eruptions like those of Hekla in 1913 and of Katla in 1918. Most of this material, has, of course, been published before in various ways, but it is here for the first time gathered all together between the covers of one volume.

During his travels the author found 130 postglacial volcanoes or places of eruptions in Iceland, by far the most numerous of which were volcanic fissures and crater rows. It has been generally considered that about 30 of these volcanoes have been active during historic times, which cover the last ten centuries; in the author's opinion, it is absolutely certain that at least 23 have been active. Of these, seven are conical volcanoes, eleven volcanic fissures, three or four explosive craters, two or three craters covered by snow or ice, and three or four submarine volcanoes. Ten of the volcanoes have had more than one eruption. Recorded eruptions number 138, some of which the author considers doubtful, while presumably a great many have remained unrecorded. The record is most reliable for the eighteenth and nineteenth centuries and gives 36 eruptions for each of these two centuries; hence it seems plausible to the author to assume that 30–40 eruptions have taken place on the average during each century. Hekla has had 21 eruptions (some of these from craters in the neighborhood of the mountain); Katla, 13; Eldeyjar (off Reykjanes), 10 or 12; but by far most numerous are those taking place in Vatnajökull, that is 38–40; and probably most of them from the same place near Hágöngur. Not very far from this is the Laki crater row where the largest of all the eruptions on record occurred in 1783, pouring forth from some hundred craters a lava field of about 565 square kilometers, probably the largest lava stream on the surface of the earth produced within historical times during a single eruption. The final chapter on the connection between the activities of the Icelandic volcanoes is of particular interest.

The work contains, however, more than the title indicates. The second section (pp. 264–379) gives a long description of hot springs in Iceland, their physico-geological condition and geographical distribution. Of alkaline springs there are known about 677 in 162 different localities; most of them are found in large groups, numbering, according to the author, about 65; comparatively few are isolated, and about half a hundred have not been investigated. Numerous sulphur springs are also to be found, chiefly in the southwestern and northeastern parts of the country; these formerly yielded much sulphur for the market. Carbonic acid springs, called in Icelandic (*ölkeldur*) "ale wells," are especially met with on Snæfellsnes, but they have never been used for any practical purpose.

The third and last section (pp. 380–458) deals with earthquakes in Iceland from 1013 to 1908, giving a list of all on record and whatever information could be gathered about them. The earthquake of 1896 is treated of at great length; this was one of the most severe in recent times and one that caused much damage.

Dr. Mohr's book has the subtitle, "Chat from the Polar Circle"; and chat indeed it is, though not of the interesting kind. Although the author apparently stayed in Iceland for a year or more, his knowledge and understanding of men and matters there are most superficial. He is apparently a journalist (he refers, at least, to himself as "Federvieh"), who makes disastrous attempts at writing humorously. He does not really mean to write in an unfriendly spirit, and yet the book on the whole leaves a bad impression; besides, he has the presumption to write whole chapters on subjects which he has no qualifications to write about, like the Icelandic language and geology. And he advances all kinds of new theories, such as that regarding the origin of the name of the country. He dismisses as unreliable the tale about this to be found in the *Landnámabók*, and positively asserts that the name is to be traced to the big glaciers in the southeastern part which are first sighted when one approaches the country from the southeast. It requires but little acquaintance with the language and with Icelandic place names to see that in such case the name would have been "Glacierland" and not Iceland. But it is useless to enter upon any detailed criticism of such a work. The only redeeming feature of it is the pictures, principally from photographs, some of which have been published before; most interesting, however, are the five colored reproductions of paintings by the Icelandic painter, Ásgrímur Jónsson.

Of a different kind is H. Erkes' article. He has made many trips to Iceland especially with the view of exploring some little-known parts of the interior, to the geography of which he has made valuable contributions; from time to time he has published accounts of these trips in various German periodicals. The present article deals with his journey in 1924 across the country over the route of Sprengisandur and his visit to some out-of-the-way places there (Illugaver and Nýidalur), all of which he describes most minutely. He intended to ascend Vindheimajökull in the north but was prevented from so doing by bad weather; instead he gives a most detailed description of the surroundings of this glacier. An eighth journey made in 1926 is described in a recent number of *Petermanns Mitteilungen* (Vol. 73, 1927, pp. 159–161.)

The directors of the National Bank of Iceland, which began operations on July 1, 1886, have had the happy thought of celebrating its fortieth anniversary by publishing a little manual on Iceland under the editorship of Mr. Thorsteinsson, director of the Statistical Bureau of Iceland. Although a volume of less than 200 pages, its gives much information about Iceiandic conditions. It includes articles by various writers on the geography of the country, population, constitution and law, state and municipal finance, agriculture, fisheries, handicrafts and industry, trade, financial institutions, money, weights and measures, communications, social conditions, church and religion, education, literature, fine arts, foreigners in Iceland, Iceland for tourists, etc. In spite of the fact that all this is in a summary form, it gives a good idea of the progress made by Iceland since the constitution was granted in 1874 and in the first few years of its political independence. There are many tasks to be shouldered by a nation of one hundred thousand inhabiting a country of over a hundred thousand square kilometers; and so far the Icelanders have faced them squarely. Down to 1874 they lived under the paternal government of the Danish kings, who did but little to improve their condition or develop the country. To mention one example, hardly a foot of real roads had been built by the government down to that date, and people were still traveling by bridle paths as in the saga times. There were no coastwise sailings, and a single mail steamer made a few trips annually between the government and the governed. Great changes have been made. Roads and bridges have been built in all the most populous parts of the country, although there are as yet no railroads. Three steamship lines, one of them Icelandic, maintain connection with foreign countries, while coastwise sailings are frequent. Most noticeable has been the development of the fisheries, which now are carried on largely by steam trawlers and motor boats—the fish export for 1923 amounted to 37,000,000 Icelandic crowns. Agriculture has not progressed in the same proportion, although advancement also is noticeable there, and great irrigation plans are under way. Little has as yet been done to utilize the immense water power of the country, but this will doubtless be done in the near future. The financial situation is better than in many other countries, the national debt amounting to about 16,000,000 crowns, 10,000,000 of which are external loans. There are two banks in the country and 50 savings banks, the total capital of the latter having increased from 1,363,000 crowns in 1911 to 7,319,000 crowns in 1923. To any one interested in Iceland or Icelandic affairs this little volume can be recommended. Unfortunately it has no map of the country—an omission that should be remedied in a new and enlarged edition.

HALLDÓR HERMANNSSON

RURAL SETTLEMENT IN BELGIUM

M. A. LEFÈVRE. **L'habitat rural en Belgique: Étude de géographie humaine.** vi and 306 pp.; maps, diagrs., ills., bibliogr. H. Vaillant-Carmanne, Liége, 1926.

This interesting and richly and carefully illustrated work is probably one of the first of its kind. It first devotes some 72 pages to the types of distribution of rural houses, next it takes forms of villages and their typical sites, next the density of

rural houses and its cartographical representation, as well as the representation of historical changes of that density as far as they can be ascertained. Almost 130 pages are given to a most valuable regional survey of the types and features of houses and farm buildings. There is a long and serious bibliography. The comprehensive character of the work is thus very obvious. Miss Lefèvre has learnt well from her teachers, Professors Michotte and Demangeon. Three large folder maps are added; one gives the region of dispersion of houses as contrasted with the region of their agglomeration and marks hamlets, roadside villages, industrial agglomerates, indefinite villages, etc., in their main regions; the next gives a map of the densities of rural houses; and the last distinguishes various kinds of houses and farm buildings and gives their distributions. Such a study is of special value in a land of historic culture as, unless men are very much alive to the features of their heritage, much is only too likely to be swept away by the influences arising from the dominance of mass production. The study of houses and of forms of settlements has great interest for the humanist, as they are often clues to natural tendencies; they are features that have grown up and are often by no means the result of mere deliberation. Miss Lefèvre's work on houses needs to be imitated and extended in other regions. Her view is that the "Gewanndorf," or village with common fields and strips, is a post-Roman and post-Salian introduction; and thus she goes even farther than Meitzen. When, however, we reflect on the distribution of prehistoric finds and their hints of ancient settlement such a late origin of rural communities seems difficult to accept fully, though it is very likely that the village system underwent considerable changes after the days of the Roman Empire. The subject is a difficult one, and we praise Miss Lefèvre's effort to mark out proper lines of investigation.

H. J. Fleure

A Summary Account of Asiatic Ethnography

L. H. Dudley Buxton. **The Peoples of Asia.** xiii and 271 pp.; ills., bibliogr., indexes. (Series: The History of Civilization.) Kegan Paul, Trench, Trubner & Co., Ltd., London; Alfred A. Knopf, New York, 1925. 12s. 6d. 9½ x 6½ inches.

This book by Professor Buxton on the ethnography of Asia embodies the latest available material and is well and interestingly written. It forms one of the volumes devoted to Historical Ethnology in the "History of Civilization" series, edited by Professor C. K. Ogden, of Magdalene College, Cambridge, and, like its companion volumes, possesses a very attractive make-up. Beyond doubt it is one of the most important works in the field of human geography that has appeared for some time.

In the opening chapter there is a somewhat full discussion of the work of the Biometric school. The author justly attaches much importance to its methods, although he is perhaps inclined to overestimate the value of purely mathematical processes. In this connection he might perhaps have made more of the fact that "pure" races in the strict sense have never existed. The evidences of racial mixture go back at least as far as the Upper Paleolithic. The second chapter, devoted to an enumeration and description of the races of Asia, lists five human types as occurring in that continent: (*a*) the Nordic, (*b*) various groups of the "Brown," or Mediterranean, race, (*c*) certain subraces akin to the Alpine stock of central Europe, (*d*) the great group of Yellow Men, and (*e*) the Negritos, with a small number of isolated tribes living in southeastern tropical Asia. The question of the origin of the Asiatic races, discussed in the third chapter, could not of course be entirely ignored; but, as our author himself shows, it is impossible in the present state of our knowledge to reach definite conclusions.

Chapter IV treats of western Asia. In it the author shows that two main races of man occur there, the Mediterranean and the Armenoid, and that such things as

an "Arab" or a "Semitic" type do not exist. The following chapter, on India, is one of the longest and best in the book and bears striking witness to the greater fullness of our knowledge of that part of the continent; the discussion of that group of sociological factors comprised under the term "caste" is especially well handled. In the next chapter, however, that dealing with China, Professor Buxton is on less certain ground and quite properly treads more softly. He points out (p. 159) that although the various groups classified under the name "Chinese" belong overwhelmingly to the Yellow races, the term is not to be associated with any physical type but is cultural and linguistic. With one of our author's suggestions, to the effect that traces of the "Brown," or Mediterranean, race exist in China and that it reached that country from the south, most students will probably disagree, as indeed some have already done. The chapter concludes with a conservative summing up of Chinese ethnic strains and a fair admission of the insufficiency of our knowledge.

Chapters VII and VIII, entitled respectively "The Fringed Lands of China" and "Arctic Asia," give good summaries of the little that we know about those regions. The ninth chapter, on Japan, is naturally far more satisfying. The work of recent investigators, particularly Japanese, is discussed at length. Among other points of interest, the author notes (p. 219) a resemblance in physical type between one element of the Japanese people and some of the hill tribes of southeastern China. He might here reinforce his argument with historical and cultural evidences. Ancient Chinese writers tell us that the people of Wo (southwestern Japan) have customs like those of the inhabitants of Wu, the old non-Chinese feudal kingdom embracing the Yangtze embouchure region. And the basic culture of historical Japan, especially its technique of rice growing, is merely a slightly archaic form of that which has flourished in the great central basin of China from time immemorial.

In Chapter X Professor Buxton describes southeastern Asia and Indonesia. In his usual clear and vivid style he gives here (pp. *222 et seq.*) an excellent picture of jungle and river life and their effects on mankind. These are exceedingly important. For identical conditions of existence must have prevailed over the entire monsoon belt, from western India to eastern China, throughout the human period, until the introduction of metal three or four thousand years ago first enabled men to master and clear away the forest growths. Unfortunately no authority is given for the statement (p. 225) that Sumatra may have been joined to Malacca as late as the second century of our era. If this were true, it would go far toward explaining the late introduction of sailing craft into Far Eastern waters, where they seem first to appear only about that time.

In the "Summary and Conclusions," forming the eleventh and final chapter, the author points out that a considerable immigration of Europeans into Asia has taken place in recent years, with a "corresponding immigration [*sic*] of Asiatics out of their own continent." Possibly the drift of population from European Russia into Siberia may counterbalance that from southern Asia and particularly China to other parts of the world; dependable figures for the former movement are not available. Leaving Russia out of the picture, however, the migration out of Asia is incomparably greater than that into it and would be greater still but for artificial legislative barriers. It has probably been going on since prehistoric times and is one of the most significant facts in the history of mankind.

The bibliography is fairly comprehensive but would be improved if specific page references were more generally given. The indexing is on the whole complete; but here again there is a certain lack of definiteness. The eight plates of Asiatic racial types are decorative rather than truly illustrative. A serious defect in a book dealing specifically with human geography is the total absence of maps, in the text or elsewhere. The faults in Professor Buxton's book, however, are trivial in comparison with its merits, for it is a careful and painstaking account, based both upon personal observation and upon unusually extensive study. An understanding of the racial

history of Asia is the key to the whole history of mankind. In helping us to achieve this understanding, "The Peoples of Asia" performs a really important service. A new edition, a few years hence, to keep us abreast of the progress of the investigations now going on, will be most welcome.

C. W. BISHOP

GEOGRAPHY OF WORLD TRADE

JOSEPH PARTSCH. **Geographie des Welthandels.** 358 pp.; index. Ferdinand Hirt, Breslau, 1927. Rm. 22. 9½ x 7 inches.

The late Dr. Partsch, a clear thinker and thorough research worker, Ratzel's worthy successor, passed away before he could complete this last work. Thanks to former students and friends, the editing and publication of the manuscript has been made possible, and in consequence an important contribution to the field of geography has been effected.

Partsch was always a pioneer, but his modesty retarded a full appreciation of his work by his contemporaries. Just as he was one of the first geographers to recognize the value of a regional treatment of his science, well developed in his "Central Europe," still a standard work, so in his "Geographie des Welthandels" he blazes a trail by his departure from the method of treatment that characterizes most of the commercial or economic geography texts.

Partsch intended to treat the subject in three parts, of which two appear in this volume, namely (1) the varying conditions under which man lives upon the earth and which give rise to exchanges and (2) the distribution of the world's goods which enter into world trade. The third part was planned to include a consideration of the means of distribution and of trade centers. In Part I density of population, races, language, religion, and political organization are treated, groups of facts being presented first under the respective headings followed by a statement of the geographic significance of the group in the world's trade. Under Part II the distribution of the world's goods is presented regionally according to place of origin and subsequent development in other parts of the world. On this basis, treatment of plant and animal products of the land occurs by climatic regions, while products derived from the seas are discussed under a division of the seas largely climatic in character. Minerals receive attention in a special section. This treatment represents a distinct departure from that to which we have been accustomed. For example, American cotton production and trade are treated under "Products of the Monsoon Regions in Southern and Eastern Asia," while tobacco finds a place under the subdivision, "Summer Drouth, Subtropical Region." On the other hand, cane sugar is discussed under the heading "The North Temperate Zone as a Primary Center for Agricultural Activities." It is introduced here because the sugar beet has been a critical factor in European life, beet sugar having not only had to face competition with cane sugar, but having been confronted with the problem of maintaining itself upon the world's markets.

Partsch never loses sight of his viewpoint. He consistently keeps commodities in motion and quite as logically reduces economic discussion to a minimum, introducing it only as an incident to the movement of products. Likewise he recognizes the non-geographic influences in trade such as coinage, the telegraph, trade politics, and tariffs, remarking as follows about the last item: "It is surprising how generally handbooks of commercial geography entirely omit mention of tariffs" (p. 67).

Unfortunately the third part, on trade routes and trade centers, which Dr. Partsch planned to include, has been omitted; but there is hope that this may yet appear as a unit volume. It constituted a phase of geography which, in recent years, appealed strongly to the author.

EUGENE VAN CLEEF

An Industrial Map of the World

Olof Jonasson. **Näringskarta över Jorden.** Scale 1:20,000,000. 4 sheets. Generalstabens Litografiska Anstalt, Stockholm, 1926. Kr. 23.

Näringskarta is a colored wall map on the Mollweide equal-area projection with four colored insert maps of the world on the same projection (equatorial scale, 1:80,000,000). These show (1) temperature data and mean annual precipitation, (2) topography, (3) natural vegetation and ocean currents, and (4) the commercial languages of the world and the origin and movement of Swedish foreign trade. The wealth of detail in the principal map marks it as a scholarly production, the value of which is enhanced by well chosen colors and beautiful lithography.

Although the principal map carries some facts relating to climatic conditions, ocean trade, and the distribution of the manufacturing industries, it is primarily a map of the use of land—agricultural, pastoral, and forestal. This difficult and complicated subject is handled in a manner pleasing to the eye by a method that appears, on first sight, relatively simple. The plan involves the subdivision of the land of the earth into five major types of regions on a basis of use, each of which is distinguished by a general underprint in one color. The types of regions are (1) agricultural, or temperate, regions (yellow); (2) subtropical fruit, or Mediterranean, regions (green); (3) plantation, or tropical, regions (blue); (4) rice, or monsoon, regions (red); and (5) unproductive regions (gray). These colors are superimposed upon a base with coast and rivers in deep blue and unobtrusive topographic shading in dark gray. That the broad generalization of this classification is sometimes too sweeping is seen in the fact that the subtropical fruit, or Mediterranean, region is made to include, in addition to the regions of truly Mediterranean climatic type, nearly all of eastern South America from Santos to Cape Horn.

Subdivision of these major regions is accomplished by means of shades or tints of the principal color or by overprints. One can but admire the skill with which this is done, for there are in all thirty-nine color and symbol combinations. Yet there is no confusion, and the general effect is harmonious. The interpretation of these combinations is, however, a different matter. Not only are many of the unit areas too small to be seen clearly at classroom distance, but they have not always identical significance. Thus: in the temperate region a deep orange yellow signifies, for Europe, the region in which wheat, vines, and sugar beets are the principal products and marks approximately the northern limit of the vine. For North America, the same color signifies a region in which the principal products are tobacco, wheat, and maize and marks approximately the northern limit of plantation agriculture. One of the tropical blue combinations has three different, although similar, meanings in the three continents in which it appears. Some colors have one significance only.

These complications are perfectly intelligible upon close inspection, but they greatly decrease the usefulness of a wall map. Indeed, it is the feeling of the writer that Dr. Jonasson's excellent map will find principal use in American classrooms as an object of close laboratory study by individual students. For that use its present form is not convenient.

V. C. Finch

A History of Seismology

Charles Davison. **The Founders of Seismology.** x and 240 pp.; maps, diagrs., index. The University Press, Cambridge; The Macmillan Co., New York, 1927. $4.25. 8½ x 6 inches.

Davison considers that seismology as a science was founded when investigators broke loose from the speculations of the ancients and based their conclusions on contemporary observations. He fixes this time as the middle of the eighteenth century,

when the important but little known account of the Lisbon earthquake of 1755 by John Michell was published. After a preliminary chapter on some earlier writers he devotes special chapters to John Michell, Alexis Perrey, Robert Mallet, Fernand de Montessus de Ballore, John Milne, and Fusakichi Omori. There are chapters also on the study of earthquakes in Italy, in Central Europe, and in the United States. Though naturally confining his attention to those whose life work is ended, he makes some reference to living students in the last three chapters mentioned.

Davison begins his account of each investigator with a short biography, then analyzes his work with full references to the places of publication, and finally gives his estimate of its value. This method emphasizes the fact that all our knowledge is due to the work of individuals and does not simply grow of itself.

It is interesting to note how early some ideas, still current, originated. Michell, for instance, clearly recognized that earthquake motion was propagated as elastic vibrations; and he described the method of finding the epicenter by the direction of the motion, a method later developed by Mallet. He also showed how to find the distance of the origin of some submarine earthquakes by the difference in time of arrival of the shock and the sea wave. Again, the Italians recognized the influence of the terrain on the destructive effects of a shock more than a hundred years ago. It is curious to note how closely the work of de Montessus de Ballore paralleled that of Perrey. Each devoted his life to the making of a great catalogue of earthquakes and used it to test laws of periodicity and as a basis for regional memoirs. But de Montessus went further and connected the earthquakes with the geology and topography of the region.

The book is an interesting and valuable addition to seismological literature. Seismologists may differ somewhat with Davison as to the relative values of the various investigations recorded, but this is a matter of personal opinion. It will add to the interest of the book and will not detract from its value.

HARRY FIELDING REID

POSTGLACIAL MOVEMENTS IN GREENLAND AND SPITSBERGEN

THOROLF VOGT. **Bretrykk-teori og jordskorpe-bevegelser i arktiske trakter i ny tid (The Theory of Ice Pressure and Movements of the Earth's Crust in Arctic Regions in Modern Times).** *Norsk Geogr. Tidsskr.*, Vol. 1, 1927, No. 6–7, pp. 336–386.

The west coast of Greenland and the Thule District, or the region north of Melville Bay, are undergoing submergence. This is primarily shown by drowning of ruins of houses built by Eskimos, by Northmen during their colonization between 982 and the sixteenth century, and by Danish settlers since 1721. The submergence at Godhavn amounted to 15 centimeters between 1897 and 1923, i. e. in 26 years. The rate is thus 58 centimeters in one hundred years. Whether East Greenland is being submerged or not is yet unknown.

Spitsbergen, according to A. E. Nordenskiöld, is rising, and according to other authors is stationary. Vogt, however, finds several contrary lines of evidence. Many ruins of winter huts built by Russian hunters and trappers between about 1715 and 1850 lie remarkably low; one even is reached by the waves. The sea cliffs, the interior of the fiords, the submarine shelves lining the fiord walls, and drowned valleys, suggest transgression; while the great difference between the modern molluscan fauna in Ice Fjord and the subfossil fauna even of very low raised shell beds indicates either a long standstill at the present level or submergence in recent and modern times.

None of the conditions mentioned affords certain evidence of submergence in Spitsbergen, but they make this highly probable. In Jan Mayen, Bear Island, and Novaya Zemlya the shore line may either be stationary or rising.

Modern transgression in Greenland and Spitsbergen is believed by Vogt to be due to depression of the land by growth of the ice sheets since the postglacial temperature maximum which according to records in Sweden prevailed from about 7000 to 3500 or 2500 years ago and according to archeological records in central Europe ended about 850 B. C., or 2775 years ago. At the time of the temperature maximum the glaciers in both Greenland and Spitsbergen had less extent and thickness than today. However, if they were smaller the sea level then stood higher than today. Subsequently, as the glaciers grew, both the sea and the land sank. To the apparent sinking of the land, the amount of transgression, should therefore be added the amount of the lowering of the sea level. If this latter since the temperature maximum is 5 meters, as R. A. Daly now thinks, the actual recent sinking of Spitsbergen amounts to some 11 meters, not 6 meters, as Vogt states.

ERNST ANTEVS

SOME STUDIES IN PLEISTOCENE GLACIATION

PAUL KESSLER. **Das eiszeitliche Klima und seine geologischen Wirkungen im nicht vereisten Gebiet.** 210 pp.; maps, diagrs., ills., indexes. E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart, 1925. 13 M. 9½ x 6½ inches.

HERBERT LOUIS. **Die Verbreitung von Glazialformen im Westen der Vereinigten Staaten.** *Zeitschr. für Geomorphologie*, Vol. 2, 1927, pp. 221–235.

PAUL BECK. **Eine Karte der letzten Vergletscherung der Schweizeralpen.** 53 pp.; maps, diagrs., bibliogr. (Naturw. Gesell. Thun, Mitt. 1.) Geographischer Karten-Verlag Bern, Kümmerly & Frey, 1926. 9 x 6 inches.

The climatic modifications during the glacial epochs, affecting practically the whole globe, were especially pronounced in the proximity of the ice sheets, for instance in the region between the North European ice and the expanded glaciers in the Alps, the region treated in the first mentioned paper.

The lines of evidence employed in the study are the present climate about the existing ice sheets, fauna and flora, and geological phenomena, the last including frost weathering, solifluction, loess which is held to be glacial in age, cirques, height of the snow line, etc. The temperature is found to have been about the same in the whole region between the two glaciers during their greatest extent. There was no distinct differentiation of tundra, steppe, and forest climate. The mean annual temperature amounted at most to –2° C. but was probably lower. The winter temperatures were very low, the summer temperatures rather high. The daily temperature variations were large and emphasized by the cold dry northeast winds sweeping down from the ice. Annual precipitation was insignificant, but torrential evaporation was very great. The snow line during the last climax lay at some 1000 meters in the Alps, at 900 meters in the southern Schwarzwald, and at 850 meters in the northern Schwarzwald, whence it rose northward, suggesting decreasing precipitation and increasing evaporation.

This volume, by the late professor of geology in the University of Tübingen, is an interesting and important study with a wealth of material.

Louis's paper, based on a study of American literature and topographical maps, treats the extent of Pleistocene glaciation in the mountains of the western United States, distinguishes the type of glaciation, viz. hanging glaciers, valley glaciers, and "net" glaciers, and demonstrates the main features on a map. The approximate snow line has also been determined. It shows that the glaciation was determined by topography and direction of the predominating winds, and also that the rain-bringing winds came from the west then as they do today.

Beck's paper summarizes our knowledge of Pleistocene glaciation in Switzerland. His main map attempts to show the extent of the greatest and of the last glaciations

in Switzerland and adjacent regions and the contemporaneous position of the ends of the glaciers when the snow line lay 200, 400, 600, 800, 1000, and 1200 meters lower than today. Another map shows the height of the present snow line. The relative rôles of ice erosion and river erosion are discussed and found to be about equal. The influence of the glaciation on drainage, etc. is also treated.

ERNST ANTEVS

TROPICAL CYCLONES

I. M. CLINE. **Tropical Cyclones.** xii and 301 pp.; maps, diagrs., bibliogr., index. The Macmillan Co., New York, 1926. $5.00. 9 x 6 inches.

The author has spent a lifetime in the study of the climate of the Gulf States and, as official forecaster in the U. S. Weather Bureau, has acquired an unusual amount of intimate knowledge of storms which have crossed the Gulf of Mexico and the Gulf States since 1900.

A large amount of original material pertaining to pressure, precipitation, winds, and clouds in their relation to the center of tropical cyclones is presented in convenient tabular form for further study by students of meteorology.

In plotting the records of all tropical cyclones which have crossed the area since 1900, Dr. Cline has employed a method of his own to show the hourly values for rainfall, wind, and clouds in their relation to the barometric center of the advancing storm. Superior merit is claimed for this method, and it doubtless enables one to present essential elements and their relationships in less space than is possible by means of synoptic weather charts; on the other hand the method does not show the distribution of wind and rainfall in connection with the vital factor of the prevailing pressure system, with which precipitation and wind direction and velocity are intimately connected. Students of meteorology will miss the familiar synoptic chart.

The author finds that: (1) The area of excessive rainfall in storms within the area studied is in front of and to the right of the center of the advancing storm. (2) Very little precipitation occurs after the center of the storm has passed. (3) The area of lowest pressure moves towards the region of greatest precipitation. (4) There is no radial outflow of cirrus clouds from the center of the cyclone, as has been maintained by well known authorities. (5) Air currents a mile or more above the earth's surface in the region of the rain clouds largely determine the direction towards which the cyclonic area advances. (6) Hurricanes seldom travel along straight lines.

Dr. Cline's investigation of tropical hurricanes is confined to storms within the Gulf of Mexico and the Gulf States—a region mostly within the area of recurve of hurricane tracks. In this area the storms are passing from a region in which the general air movement is from east to west, into a region of drift from west to east. Generalizations based upon the behavior of storms in the recurve may not, however, hold good in the first and third branches of the usual parabolic path—i. e. during the greater part of the life of the storm.

In the vicinity of Porto Rico and the Lesser Antilles, i. e. in the long first branch of the path of the cyclone, the distribution of rainfall is more nearly about the center, while the area of greatest intensity of precipitation is more likely to be behind than in advance of the barometric center; hence the area of excessive precipitation cannot here be a determining factor in the progressive movement of the storm.

Observations of cirrus clouds and pilot balloons at San Juan, Porto Rico, are in accord with Dr. Cline's statement that there is no radial outflow from the center of the cyclone in the cirrus level and that cyclones are carried along in the general drift of the atmosphere in the locality. In the vicinity of the Lesser Antilles and Porto Rico the usual direction of movement of cyclones is toward the west-northwest, which is the prevailing wind direction over Porto Rico throughout the hurricane season at an elevation of about 10,000 feet.

The statement that cyclones seldom travel along straight lines, while applicable to the area of recurve, does not hold good in the long first and third branches of the paths where storms travel in approximately straight lines for a thousand or more miles.

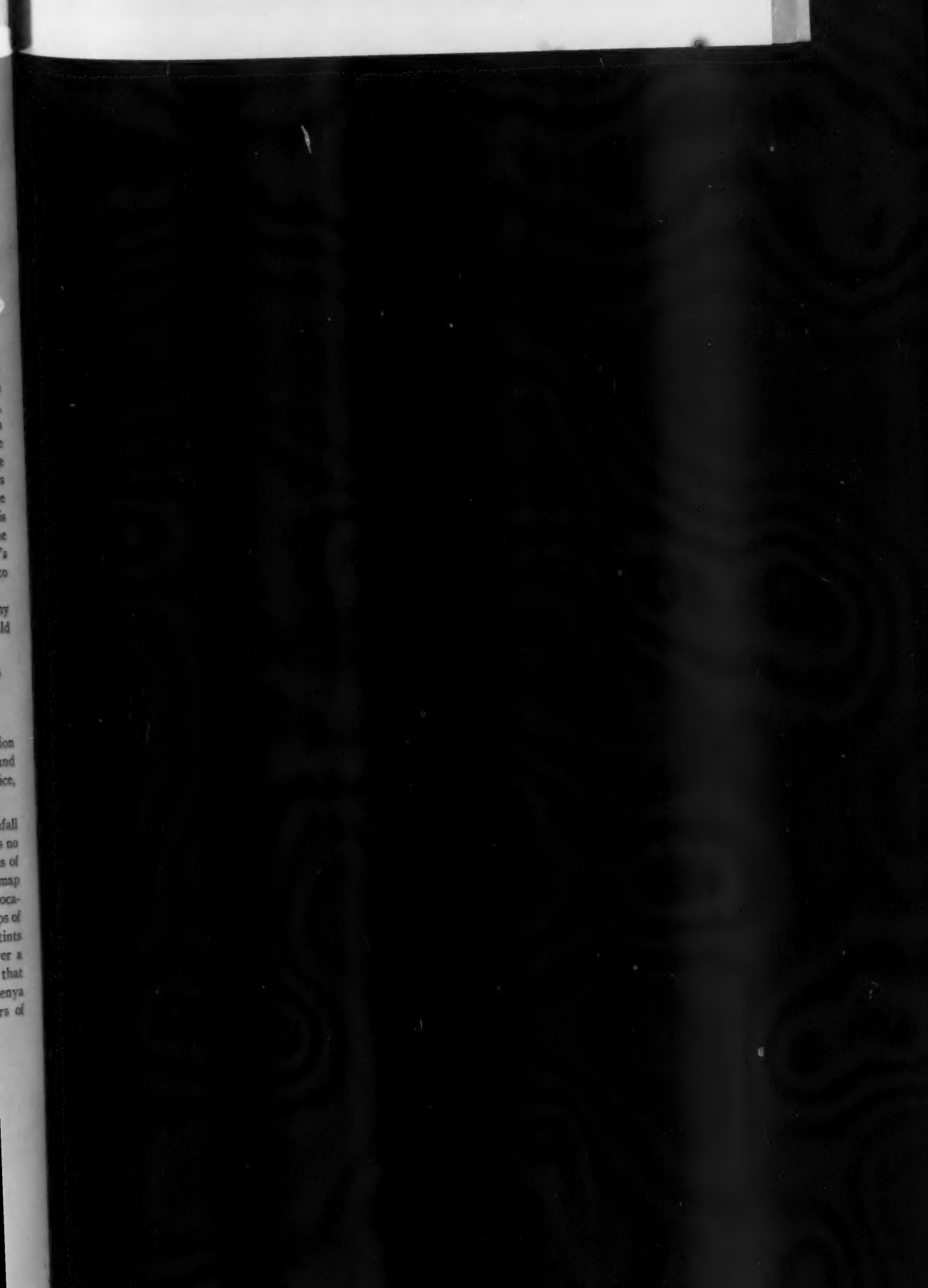
In an appendix Dr. Cline has added an interesting and valuable contribution on the relation of changes in storm tides on the coast of the Gulf of Mexico to the center and movement of hurricanes. The author finds that the waves and swells of the greatest size and length are developed in the right-hand rear quadrant of the cyclonic area, where the winds are strongest and of greatest duration in the direction of advance of the storm.

Very little light can be brought to bear upon the problem of the origin of tropical cyclones by a study of surface conditions in the Gulf region or in the region of the West Indies. Most of our storms have their origin over the Atlantic between the African coast and the West Indies and reach the Antilles fully developed. Moreover, these storms most probably have their origin in opposing currents within the region of the intermediate clouds at elevations of 10,000 to 15,000 feet and seem to be intimately associated with the increasing depth and strength of the easterly trade winds with the advance of the hurricane season. The normal depth of these winds during the hurricane season in the vicinity of Porto Rico is about 20,000 feet. The change to westerly winds above the trades is generally abrupt. Such a situation is favorable for the formation of cyclonic disturbances on a very large scale. The prevailing westerly winds may descend from an elevation of 20,000 feet to the earth's surface within less than 24 hours, while the displaced easterly trades may pile up to elevations of 25,000 to 30,000 feet within the same short period.

These rapid fluctuations are generally accompanied by heavy rains and stormy conditions. Pilot balloon observations over the breeding ground of hurricanes would be of the greatest value in the solution of the problem of the origin of cyclones.

OLIVER L. FASSIG

THE RAINFALL OF SOUTH AFRICA

A. D. LEWIS. **Rainfall Normals up to the End of 1925.** With an Introduction and Brief Summary of the Rainfall of the Union of South Africa. xiii, 109, and xxii pp.; maps. Union of South Africa, Dept. of Irrigation, Meteorol. Office, Cape Town, 1927. 13 x 8½ inches.

When it is realized that over 58 per cent of the Union of South Africa has a rainfall of less than 20 inches and that nearly 73 per cent has less than 25 inches there is no need to enlarge on the importance of this publication. The text includes tables of average monthly and yearly rainfall at all the stations of the Union and a key map and 31 sectional maps on a scale of approximately 20 miles to the inch showing location of the stations and hyetal lines 5 inches apart. There are three separate maps of Africa south of latitude 22° S. on a scale of 40 miles to the inch. One in 11 tints shows average annual rainfall; the second gives graphs of annual rainfall over a period of years for 31 selected stations; the third is a "clock" map similar to that designed by Mr. Lewis for his report on the development of water resources in Kenya (see p. 155 of this *Review*): the monthly distribution is represented by sectors of circles whose radii are proportional to the amount of rainfall.